SCIENTIFIC AMERICAN SUPPLEMENT. No. 1083

Copyright, 1896, by Munn & Co.

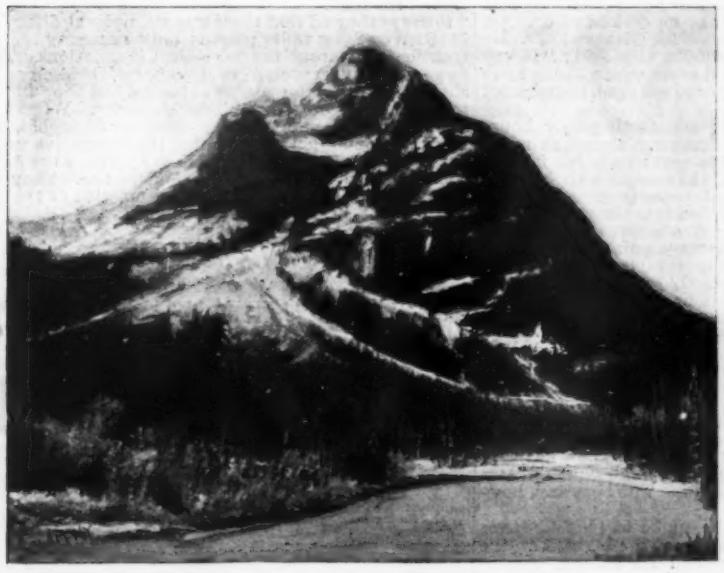
Scientific American, established 1845.
Scientific American Supplement, Vol. XLII, No. 1083. NEW YORK, OCTOBER 3, 1896. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

LI HUNG CHANG'S TRIP AROUND THE WORLD.

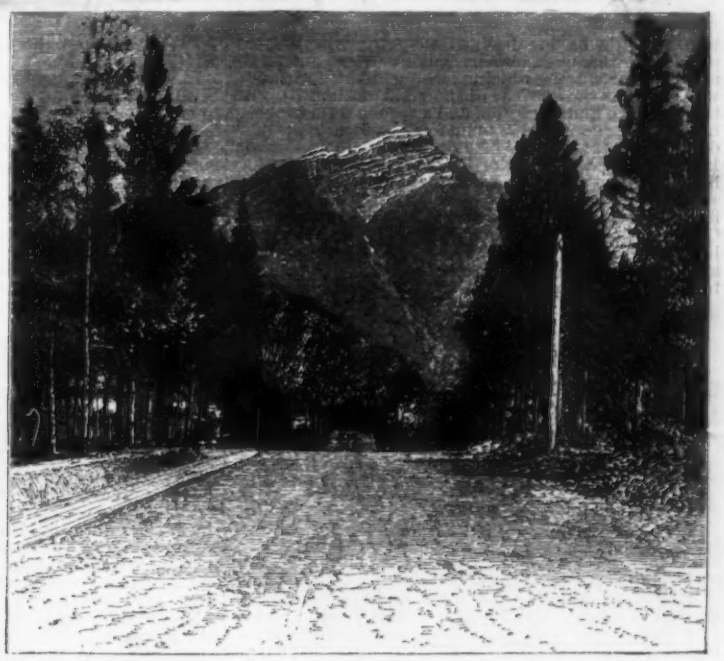
THE coronation of a Czar of all the Russias is not an every day matter, and it is just and fitting that the splendid pageant in the ancient northern capital should be witnessed by all the ruling powers, by proxy if not in person. China felt particularly bound to mark the occurrence by sending a representative whose position should comport with the dignity of Russia, who can be a powerful ally or an equally powerful enemy to any Asiatic nation. There was no precedent for selecting a prince of the imperial family, and there was no subject, except Li Hung Chang, who was sufficiently well known to entitle him to fill this exalted place. It is very doubtful if this old man, of his own volition, would have desired to make a thirty thousand mile journey around the world, or even a trip to Moscow. His "august master," however, willed him to go; his honors and decorations were given back to him, and, with the title of earl and the high office of ambassador, and a large retinue, he started for the coronation.

We have already in former articles given an account of the life of this unique figure in diplomacy, and he has been so much in the public eye during the war between China and Japan that it is doubtful if any other statesman, except perhaps Bismarck, Gladstone, or Paul Krüger, would have been regarded with more interest in the countries through which he passed. After attending the coronation ceremonies he announced his intention of returning by way of Europe and America. This was not liked in Europe. Russia wished him to go back by the Trans-Siberian Railway and France desired him to return via the Suez Canal. This desire on the part of these countries was very natural; the Viceroy was regarded as a buyer of the largest possible caliber, and it was thought that the more he saw, the more discriminating would be orders—a discrimination not always in their favor. All the governments of the old world were put in gala dress to do honor to the Chinaman, and to impress him with their wealth and power and their potentialities for defense and offense, crack troops and military organizations passed in review before him, great fleets assembled in his honor, and he conferred with emperors, kings, queens, presidents, prime ministers, secretaries of state, statesmen, warriors and a legion of lesser men. He was everywhere received with the greatest respect, and the store of information which he acquired by his constant shower of questions will last him the rest of his life.

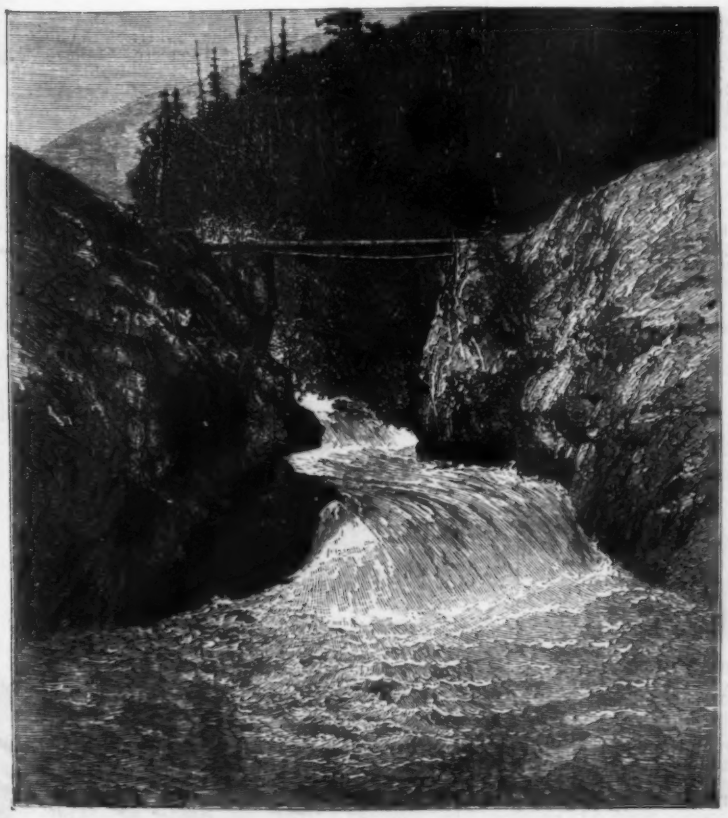
In Germany the great event was the meeting of Li Hung Chang and Bismarck at the castle of Friedrichsruhe. The two venerable statesmen, who have weathered so many wars, diplomatic and otherwise, seemed greatly pleased with each other and shook hands warmly on parting. While in Berlin the Chinese statesman visited the Charlottenburg Polytechnic, where Prof. Sloby showed him a number of experi-



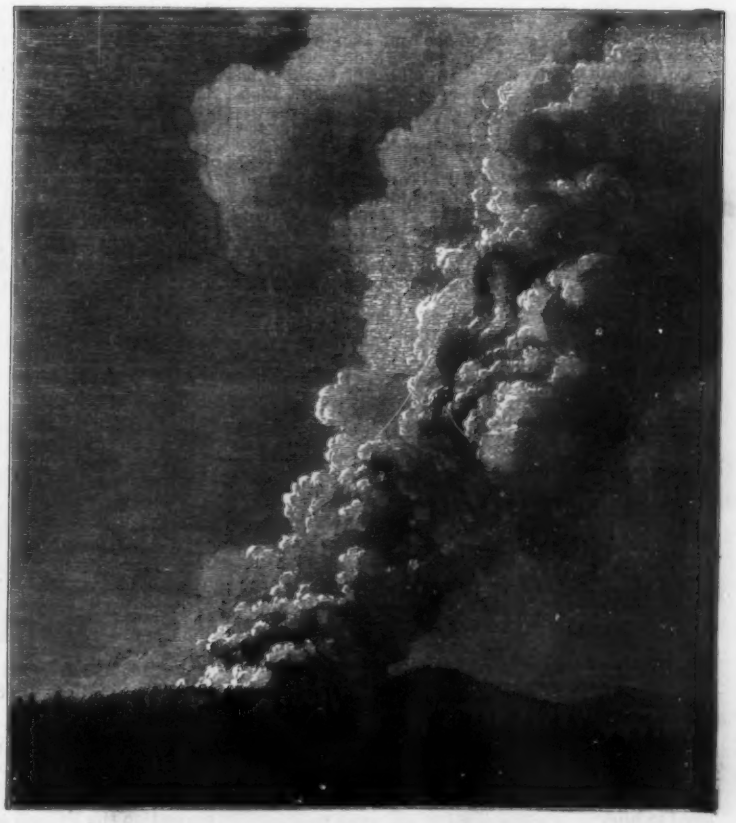
MOUNT STEPHEN IN THE CANADIAN ROCKIES.



CASCADE MOUNTAIN, FROM BANFF AVENUE.



HELL'S GATE, BEAVER CANON, B. C.



A FOREST FIRE IN THE ROCKY MOUNTAINS.

ments with the Roentgen rays. Li even consented to his own cheek being photographed to find the bullet fired by the assassin at Shimonosaki. The image which was obtained clearly showed the track of the bullet and the bullet itself. He was taken to Essen and shown everything which is usually closed to visitors in the great establishment.

Li arrived at Brussels from the Hague on July 8, and was received the next day by King Leopold. He then went to Paris, having declined the journey to Vienna, pleading fatigue. He was received with great ceremony in Paris, from which place he went to Havre, where he was shown some of the great dockyards. He then went to Southampton, and a special train brought him up to London. His temporary residence in London was the town house of Lord Lonsdale in Carlton House Terrace, where the Emperor of Germany has been more than once entertained.

While in England he visited Lord Salisbury at Hatfield House, Mr. Gladstone at Hawarden, and the Queen at Osborne. He visited many industrial establishments, inspected the dockyards at Portsmouth and was present at a review of the fleet. His tribute to General Gordon, his old friend, won him much enthusiasm. Li finally sailed on the American line steamer St. Louis and arrived in New York on August 28, where he was received with a salute of twenty-one guns from the fine fleet of the new navy. He was escorted to his hotel by United States cavalry. On the following day he was received by the President. His visit to New York was a succession of dinners and receptions; he visited Grant's tomb, and left a wreath on the grave of the general, who had always had a warm regard for him. He then visited Philadelphia and Washington, where he was interested in seeing the various sights, such as the capitol, the treasury vaults, etc.

The Viceroy was more deeply impressed with the life and character of Washington than he had hitherto been credited with. At the capitol, when he viewed the historical paintings in the rotunda, he studied that of Washington resigning his commission with greater attention than any others, and later he caused extracts of the first President's farewell address to be translated to him.

Subsequently, in response to a request for an interview regarding his impressions of the capitol, he sent out the following by one of his secretaries:

"The three foremost men in history have been Napoleon, the Chinese Emperor Yao, and Washington.

"Napoleon created an empire which was speedily destroyed.

"Yao created an empire and then proceeded himself to rule over it.

"Washington built up a great nation, then stepped aside, leaving others to govern."

Li ordered a handsome wreath to be placed on Washington's tomb, the weather not permitting him to make the journey himself, as he desired to do. On September 8 he left Washington for Niagara Falls. He was much impressed by the falls. He said: "It was more than I expected. I shall never see anything more sublime. I regret that I cannot look upon the cataract when the sun is shining."

The Earl wanted to see the mammoth power house of the Niagara Falls Power Company almost as much as he did the cataract, and the next step in his investigation was in that direction. Li carried with him the ebony cane which Mrs. Grant recently gave him. It has a steel shoe. He was carried into the power house in his chair, and at once fired questions at Superintendent Wyckes about the motors, pointing here and there with his stick. Finally the chair was carried close to one of the generators. Li put out his cane to indicate a wheel about which he was curious. From the generator a blue flame shot out, linking Li and the generator through the medium of the cane. The metal shoe had drawn the bolt.

Li's stick was jerked from his hand, and it went flying over his shoulder, hitting Superintendent Breckinridge in the stomach. A howl of anguish rose from the Chinese staff, but the Viceroy sat very calmly and never turned a hair. He said he had not been shocked, and was unhurt except for the twist the cane gave his wrist as it was torn from him. He went right on asking questions about the machines. The next day, however, he realized his danger.

Through his interpreter, he spoke in glowing terms of American enterprise, and said the sight was the most interesting he had seen in his travels. He inquired the cost of the work and the revenue and other things.

The interpreter said Li marveled much at the American railways, saying they were the greatest he had ever seen. Asked if Li would, upon his return to China, have the English engineers who are building a railroad in that country adopt the American system, he said he certainly would. This important announcement was received with much enthusiasm by the many prominent men in hearing distance.

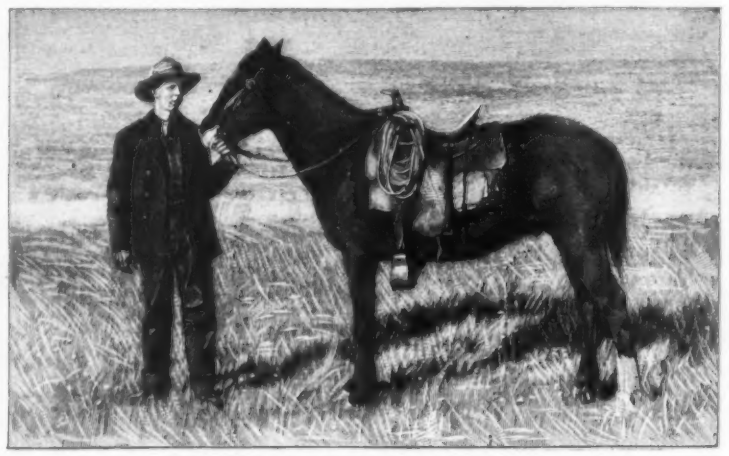
The Earl left the United States on September 7, going first to Toronto. He traveled over the Canadian Pacific to Vancouver, B. C., which he reached on September 13. He went aboard the steamer Empress of China, which sailed the next day. He was much pleased by his trip over the Canadian Pacific Railway. We present some of the scenes on this road. For our engravings we are indebted to the London Graphic.

In connection with Li Hung Chang's remarks cited above it is interesting to look at the first railway of China, which was built through the efforts of Li Hung Chang himself. The construction of the Shanghai railway was carried out against strong opposition on the part of the people and government, but in spite of this opposition the English engineers succeeded in building it. In 1876 the Viceroy of Petchili, Li Hung Chang, allowed Mr. Kinder, an English engineer, to build a railroad which would permit a rich coal mine belonging to him to be worked in an economical manner, or rather to enable the coal to be economically transported to the mouth of the Woo-Sung. The old method of transporting the coal was by boats dragged by men as shown in our engraving. Mr. Kinder proposed to Li Hung Chang to construct the railway with the aid of English capital. In return the company, of which he was to be engineer in chief, was to receive a concession or right to work the road for sixty years and the exemption from duty of all materials imported for the construction of the road.

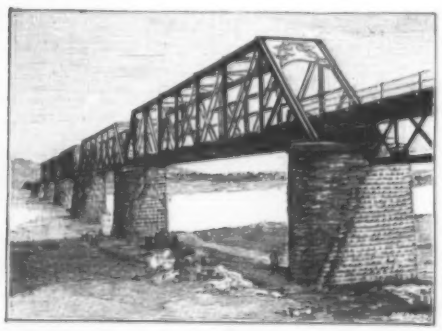
Surveys showed that there was no natural difficulty in the Woo-Sung valley; it was only necessary to protect the tracks from the periodical inundations. The new company expected to reimburse themselves in short order after the road was begun, but they unfortunately suffered from Chinese duplicity. When the first train left the port of Woo-Sung for Shanghai, the ignorant population thought that the locomotive was a fiery dragon. They did not dare to approach the monster which was spouting out fire and smoke. They all believed that it was an abominable creation of the infernal regions. The mandarins could not see how the Viceroy could tolerate such a thing; they believed that the spirits of their ancestors would be troubled in their eternal sleep by the new railway. The mandarins prayed Li Hung Chang to suppress the railway, arguing that it would bring calamity on them all. The astute Viceroy did not dare to revoke the concession which he had given to the man who had often rendered him good service, but he made his inferiors believe that he would be pleased to see the railway destroyed beyond repair; in other words, that he was secretly opposed to the enterprise, which of course he was not. Nothing more was required to start a popular tumult.

In a few hours, rails, locomotives and railway cars were thrown into the Woo-Sung, notwithstanding the energetic opposition of Mr. Kinder. Only the bridge shown in our engraving remained, thanks to its solidity. Mr. Kinder made strong representations to the Viceroy, who promised all that Mr. Kinder wished; he even swore to punish the guilty ones, but he formally op-

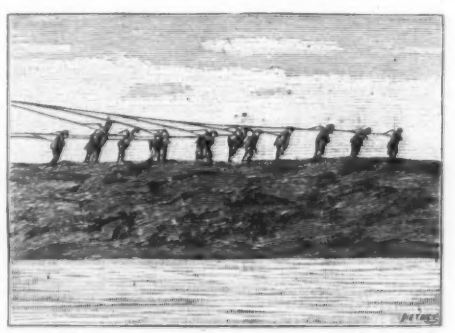
A "ROLLWAY" FOR TIMBER ON THE SPRAY RIVER, NEAR BANFF.



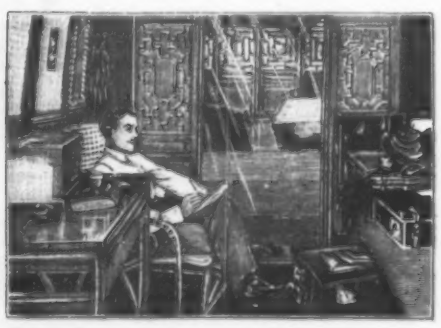
A COWBOY AT ALBERTA.



BRIDGE OVER THE WOO-SUNG, NEAR SHANGHAI.

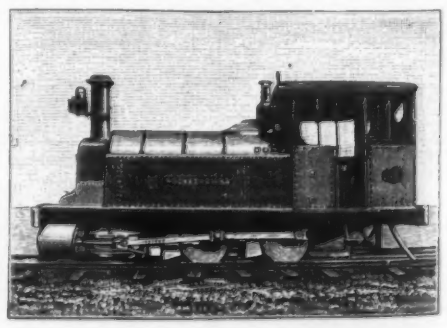


SYSTEM OF WATER TRANSPORT OF GOODS.



INTERIOR OF LI HUNG CHANG'S PRIVATE CAR.

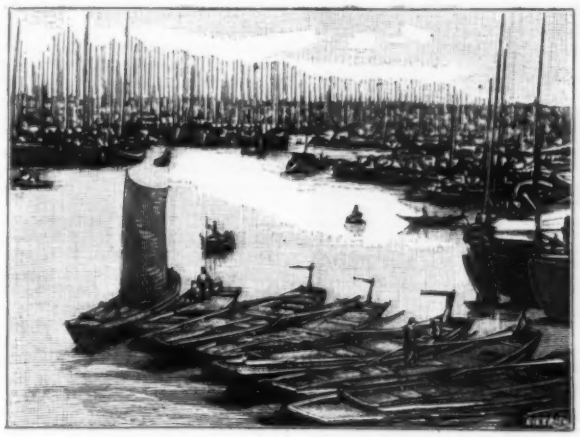
BANKS OF THE WOO-SING-HONG-SHAN.



LOCOMOTIVE DRAWING THE CAR OF LI HUNG CHANG.

posed the re-establishment of the line. However, as the line was of personal value to Li Hung Chang, he authorized the engineer to replace the iron rails by wooden ones, and on these new tracks wagons were to be run which were to be pushed by men. The Viceroy claimed that this was the only way to prevent a revolt.

In his turn Mr. Kinder resorted to a ruse. He re-established the railway under the conditions named by the Viceroy, but he had his men fish out the rails, etc., which had been thrown in the river, and gradually the iron rails replaced the wooden ones, and in time the locomotives even made their appearance. Some months after the Viceroy ceased to oppose the re-establishment of the line, and comfortably ensconced in the fine compartment car shown in our engraving he passed over



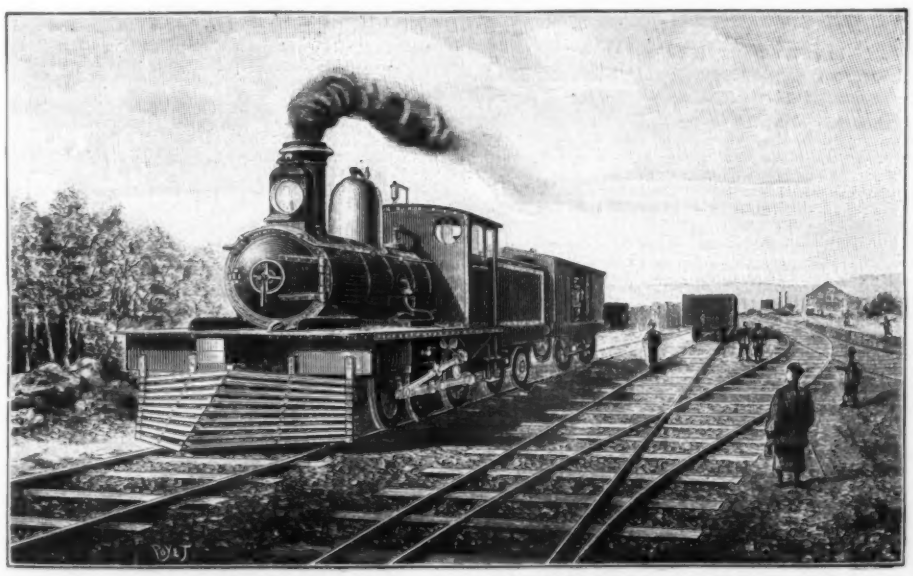
THE CITY AND HARBOR OF SHANG ON THE WOO-SUNG RIVER.

the line, formally inaugurating it. Such is in brief the story of the building of the first Chinese railway as related in La Nature, to which paper we are indebted for our engravings of the railway.

THE MIGRATION OF BIRDS.

By CHARLES DIXON, author of "The Migration of British Birds."

THE passage of migratory birds each year to and fro between their nesting places and their winter homes is one of the most interesting of all natural phenomena, and at the same time, notwithstanding the attention it has received from naturalists, one of the least understood. From the very earliest periods of recorded time the migration of birds appears to have been a special subject of man's attention. The prophet Jeremiah eloquently comments upon the migration of four well-known birds of passage in the East: "Yea, the stork in the heaven knoweth her appointed times, and the turtle, and the crane, and the swallow observe the time of their coming." Even in remoter ages it is said that the Persians and the Arabs compiled portions of their calendars from the dates of arrival of certain birds of passage; while the subject of migration was frequently



LOCOMOTIVE ON THE CHINESE RAILWAY AT THE STATION OF LONG-SAN, WHERE LI HUNG CHANG'S COAL MINE IS SITUATED.

the chosen theme of Greek poets more than a thousand years before the Christian era.

How absorbing is the interest in watching the arrival of the migrant birds in spring, from the chiffchaff and the wheatear in windy March with the first opening buds of the hawthorn, the pale primroses, and the tasseled catkins of the birch and hazel, to the laggard little red-backed shrike and turtledove at the beginning of May! Gradually, almost imperceptibly, winter is left behind.

Day by day the migrant birds arrive; morning after morning these little feathered strangers from across the sea appear unerringly, mysteriously, in the old accustomed haunts, pilgrims of the night in most cases, seeking their summer homes in darkness. One morning it is the delicate little willow wren that we see for the first time, hopping silently about the yet leafless branches, and every now and then essaying a short flight into the air to catch the still scarce insects; another morning we are just as equally charmed and surprised to notice the martins back again, gliding to and fro, twittering blithely, visiting their mud-built nests under the eaves. Or perhaps the full, rich notes of the cuckoo greet us at sunrise from the tall trees in the meadows, or the rasping cry of the corncrake startles us by its very novelty from the fields of growing grain. Throughout the month of April almost daily surprises of this sort are in store for the lover and observer of birds. Almost to the day each old familiar nook becomes tenanted by these birds of perpetual summer; some of the travelers tarry but a day and then pass on still farther north, calling at certain places with amazing regularity both in going and returning; almost imperceptibly the grand spring migration progresses, until finally each species has retired to its breeding grounds, and nesting duties, the one all-important function of the year, begin.

But scarcely has the great wave of northern migration in spring ceased to break upon our island shores before the first signs of the returning exodus in autumn begin to be apparent. Somehow the departure of our migrant friends is not without its sadness; as we miss them from their favorite haunts day by day through the mellow, brown-hued autumn each desertion brings the chill and cheerless winter nearer. We watch the swallows and the martins and the more distantly related swifts foregather in the old accustomed spots, where, may be, we have witnessed the same phenomenon for oft succeeding years, and we know full well that the display of such pronounced gregariousness is but the sign of their near departure, and the first indication of the long journey south. For weeks we have remarked the hush of song, the skulking movements, the family gatherings; and, at last, the mysterious disappearance of species after species takes place. For long the warbler band has been tuneful in nothing but in name; all song is hushed in the process of the moult; and usually the migration flight is initiated with the complete growth of the new plumage. Who can note the departure of these little feathered travelers unmoved? Who miss them from their leafy haunts without longing to speed with them toward lands of southern summer too?

It is not our intention in the present article to dwell at any length upon the purely philosophical aspects of migration, but merely to sketch a few of its most striking and most palpable characteristics. There can be no doubt whatever that the practice of migration by many birds and animals in the Northern Hemisphere is a habit acquired during the gradual range expansion of such species from a more or less equatorial base. That the practice is an acquired one is proved beyond all possibility of doubt by the fact that it is not universal among all the individuals of the same species. Thus, the individuals of many species that are practically stationary in our islands are birds of regular passage on the Continent. The robin in our country is a resident; but the robins that breed in Scandinavia, for instance, where the winters are so much more severe, draw southward in autumn, even visiting North Africa. The starling, the hooded crow, and the goldcrest are all residents in the British Islands; in many parts of continental Europe they are birds of as regular passage as the swallow is with us. Even such hardy birds as yellow buntings, ringdoves, and oyster catchers, which brave all the rigors of a British winter, never fail to leave certain continental localities at the approach of the cold season. Other instances may be given where certain species are only known as summer visitors to Britain, yet are stationary in regions farther south, where the climate is more equable. Thus, the pretty little willow wren that always visits us so regularly in April, and just as regularly departs in September, is a sedentary species in North Africa; while the sweet-voiced blackcap, only seen in summer in our islands, resides all the year round in the countries bordering the Mediterranean, as likewise do the chiffchaff and the sedge warbler. Not only does the habit of migration vary among individuals of the same species, but the actual distance traveled does so to a degree that can only be described as astonishing. For instance, many knots spend the winter no farther south than the British Islands, while others prolong their journey to South Africa, to Australia, and New Zealand, a flight of at least four times the distance. Again, the turnstone in some cases winters in Britain, but during the cold season this species is found almost everywhere along the coasts of the Southern Hemisphere, from New Zealand to South America. Some willow wrens go as far south as the Cape to winter; others, as we have already seen, journey no farther than the Mediterranean.

The causes of migration have been almost universally attributed by scientific men to want of food. Migration is described as having its origin in the retreat of birds from that scarcity or even entire absence of food in northern latitudes during winter; but the actual facts do not in any way warrant such an assumption. Birds begin their migrations both in spring and autumn long before food becomes scarce, and in the majority of cases the bulk of the young birds leave their birthplaces even from one to two months before their parents. The theory lately propounded by the present writer in his volume on "The Migration of British Birds"—viz., the "breeding impulse"—seems to be a rational explanation of the phenomenon, and this theory is supported and strengthened to a great degree by the marvelous researches of Heinrich Gätke, during fifty years' observation of avine migration at Heligoland. The subject is far too complicated to be dealt with in a popular article, but readers desirous of further information may consult the above mentioned volume, together with Gätke's great work, "Heligoland as an Ornithological Observatory," where the initiating causes of migration are fully discussed.

A few words now become necessary on what we may aptly call the conditions of flight. We have already asserted that migration is an acquired habit, but there can be little doubt that the impulse to form that habit is not only a deeply rooted one, but an inherited and instinctive impulse. Captive birds often show exceptional restlessness as the accustomed time for their departure draws near; and the cries of migrating birds of their own species will not unfrequently visibly excite them to unusual efforts to gain their freedom and join the passing flocks. Even birds in a state of absolute freedom display exceptional emotions and indulge in certain peculiar habits. They are restless, and often gather into flocks just previous to their departure. When once the long journey begins, birds apparently follow the routes which their ancient range expansion has slowly formed, and this applies not only to species but to individuals. If that route chance to be an exceptionally dangerous one, the individuals and their descendants that are in the habit of following it will continue to traverse it until every bird may become exterminated; it will never be changed. Routes followed are those which many generations of experience have rendered familiar.

Most birds moult before they migrate, and the process of changing the feathers is generally completed just before the journey begins. Much diversity of opinion prevails as to the order in which birds migrate. Some observers state that the young birds migrate before their parents, and regard this as an absolute proof of an instinctive knowledge of the way. Now, there can be no doubt whatever that the young of certain species appear, say on the British coasts, weeks in advance of the general arrival of the adult individuals. But a few old birds invariably precede the arrival of the young and also accompany them. In spite of this, many young birds go astray every autumn, lose their way, and wander far from their normal areas. A few restless old birds, then, are the first to depart south in autumn; with them a certain percentage of the young also travel. After most of the young have quitted the breeding grounds the adult males move south; then come the females; and, lastly, those which from a variety of causes have been delayed in their departure or retarded in their progress, by loss of wing feathers, weakness, or other infirmities. In spring this order is somewhat reversed, the adult males starting first, the females following, the young of the previous summer coming next, and in the rear of all the weakly and the maimed.

We also find considerable diversity in the time during which migration is performed. Some birds journey by night, some by day; some species both by night and day. The punctuality of these feathered travelers is often simply marvelous; almost to the day certain birds may be observed back again in the old familiar quarters; almost to a day they depart south in autumn.

During migration birds are in the habit, under normal conditions, of flying at vast altitudes, where they can not only command a very extensive view of the earth below them, but where the mere physical labor of flight may be performed at the least cost of endurance. As an instance of the enormous height at which birds migrate we may mention the fact that they have repeatedly been detected through astronomical telescopes crossing the disk of the sun and moon at an altitude of from one to three miles.

Of the speed at which birds travel we have few data to form any accurate opinion. Gätke makes some startling statements respecting this matter. He computes the flight of the blue-throated warbler to be 180 geographical miles per hour; that of the Virginian plover to be 212 miles. And this speed is said to be maintained for nine and fifteen hours in succession. Unfortunately, however, these remarkable figures are based on very inconclusive evidence, and we, therefore, think it wise to wait for more detailed and satisfactory observations before accepting them.

The perils that beset migrating birds on their way across land and sea are very many. Few readers can realize the enormous amount of mortality connected with the performance of migration, especially among young birds. Of the vast numbers of these latter individuals that attempt the southern passage in autumn but very few indeed return north again in spring. Fatigue arising from long continued flight, especially across the sea, is a very fatal peril. Flocks of tiny migrants may often be met with on the coast in a sadly exhausted state. As a rule, migrants do not essay a sea journey unless the weather be favorable; but the elements are fickle, sudden storms arise, gales and showers of snow and sleet and hail often overtake the migrant hosts, and beat and chill the life out of all but the strongest. Then there are the hungry birds of prey to contend with, ever ready to strike down the weakly and the unwary. Many of these raptores are migratory themselves, and time their seasons of passage to coincide with those of their victims.

Another and comparatively a new source of danger to birds on migration is the fatal attraction of lighthouses and light vessels. Fatal as the proverbial candle to the fascinated moth, these gleaming beacons on our coasts prove the death of uncounted birds each season of passage. On clear nights the birds, fortunately, rarely visit these fatal lanterns, but on dark, cloudy, and foggy nights the mortality is high. It is also a curious fact that fixed white lights are more deadly than revolving or colored ones; and it has also been remarked that after the erection of a fog horn the light has ceased to attract birds to their doom. Odd birds from time to time dash themselves against the glass of the lanterns throughout the months that the migration of birds is in progress, but occasionally vast flights appear at the beacons, and some of the scenes then witnessed are interesting and fascinating in the extreme. Here are one or two reports from lighthouses and vessels. At the Bell Rock the keepers reported: "What we think were woodcocks struck with great force. Birds continued flying within the influence of the rays of light till the first streak of day, continually striking hard all night, and falling into the sea." And again: "Birds began to arrive at 7:30, striking lightly and flying off again. The numbers went on increasing till midnight, when a vast flock swarmed in the rays of the light, and, striking hard, fell on the balcony dead, or rebounded off, falling into the sea. At 3 A. M., another flock arrived, crowded on the lantern windows, trying to force their way to the light. The noise baffled description. The birds were in thousands."

From the Galloper light vessel, moored some fifty miles off the mouth of the Thames, it was reported that on one October night from five hundred to six hundred birds struck the rigging and fell into the sea; that thousands of birds were flying round the lantern from midnight to early morning, their white breasts, as they dashed to and fro in the circle of light, having the appearance of a heavy fall of snow. Another night 160 birds were picked up on deck, and it was computed that quite another thousand went overboard. At the Tuskar Rock lighthouse, off Wexford, 1,200 birds were counted killed in a single night, and hundreds more fell into the sea! The terrific force with which some of these birds strike the lanterns is almost incredible. Woodcocks have been known to break glass three-eighths of an inch in thickness, while on another occasion a flock of ducks shattered into small pieces glass a quarter of an inch thick.

Fig. 2.—TAMER INSERTING HIS HEAD INTO A LION'S JAWS.

The enormous numbers of these migrating birds are almost past belief, especially in autumn, when the young swell the ranks of the travelers so largely. Night and day the rush of birds passing north or south, east or west, according to season, is simply prodigious. This is especially remarkable in such species as goldcrests, starlings, and skylarks. Vast waves of the first named species—the smallest of British birds—sometimes spread westward for days and nights in succession. In 1882 a somewhat exceptional migration of this bird to the British Islands took place, extending over a period of ninety-two days. This vast wave of bird life was at least nine hundred miles in breadth; not only was the goldcrest observed in swarms all along our eastern coasts, but Gätke records them from Heligoland in what he describes as a perfect storm, "perching on the ledges of the window panes of the lantern of our lighthouse, preening their feathers in the glare of the lamps; all the island swarming with them, filling the gardens and the cliffs—hundreds of thousands." The hosts of starlings and skylarks are even more remarkable. These birds cross the North Sea each year literally in millions. For days and days together flock after flock in unbroken succession, and numberless as

Fig. 1.—TIGER IN EQUILIBRIUM UPON A BALL.

the sands of the shore, speed onward in astounding hosts; square miles of birds like flakes of snow in a drifting storm! Many other birds migrate in such companies as literally to darken the skies; but, on the other hand, there are many more that seem to journey in smaller flocks, or even alone.

There is an immense amount of what we may term "internal migration" during winter. Birds at that season wander about a good deal in quest of food; and there is evidence to show that certain species move from the Continent to our milder area during the prevalence of severe weather abroad. These movements, however, are purely local ones, and always take place within the normal winter area of the species partaking in them. Mention might also be made of those irruptive movements of which Pallas' sandgrouse is one of the most familiar instances to British naturalists. These birds on two occasions have swept westward over Europe in vast hordes from their home in Central Asia, but their efforts thus to increase their breeding range have in every case proved utterly abortive, and show us that these movements are entirely abnormal.—Leisure Hour.

THE TAMERS AND TRAINERS OF WILD ANIMALS.

In London a dealer in animals showed me his collection, which, like the collections of almost all the dealers in the same line in England, was very badly installed. In the yard there were brown bears languishing in damp packing boxes that were so light that I should have hesitated to confine a bull dog therein. Lions and panthers were crowded in old garrets. They were seen through small latticed windows and the doors were simply strengthened with boards.

"Are you afraid?" said the dealer to me as he put his hand upon a bolt.

"In the first place, is there any danger?"

"None. Simply follow me step by step, and I will show you a beautiful panther."

We entered a low room with a dirty floor, in which gnawed bones and reddish foot marks did not give a very reassuring impression.

But the dealer said something that made me smile: "You are going to see a taming by means of an umbrella."

In fact, he had his umbrella in his hand, and it was by means of this that he dislodged the animal by threatening it with the handle. We passed from one corner to another of the room in locking step, and pursuing the panther, which was more cowardly than a tomcat. But scarcely was the door closed behind us than the beast threw himself against it, and, inserting his claws in the wood, shook it with great violence.

My tamer with the umbrella was not so extraordinary a person as might be thought. The curious representation of October 29, 1894, at the Lebrun menagerie installed at Sedan, is a proof of this. During the course of that evening, a Mr. P. entered the lions' cage alone and made the animals work as if he were a professional trainer. It is not necessary to declare that it is a miracle. In fact, as soon as you open the cage of a wild beast you will see him take refuge at the opposite extremity. If you do not advance, he will remain motionless and upon the defensive. If you advance with a threatening gesture, he will endeavor to escape. Leave him then a narrow passage at the side, and he will spring at you. Pursue him thus more or less quickly, and it will afterward suffice to place an obstacle in his way in order to have him immediately leap over it. Tamers, as may be seen, have no need of a lengthy apprenticeship. Their art consists in "dramatizing" the pursuit by introducing times and repetitions into it, in appearing as far as possible to subdue the will of the animal, in making it hesitate to jump over a bar, then in allowing it to jump, and in making a lavish use of the crack of a whip. It has, doubtless, been remarked that animals become bold as soon as they feel that they are under shelter and at home. Go to look for your cat under a bed and he will give you a stroke with his claws, while he would in nowise dare do so in an open space. Tamers draw from this instinct the great effect of their egress, which is produced by facing the reclosed gate, against which the animal does not fail to throw itself.

It is unnecessary to say that the "magnetic look" and the "passes" for lions are designed to make an impression upon the spectators alone and not upon the animals. As for mutilations, they are very rare, and the methods that consist in a brutal treatment of the animals of menageries are very little employed, because they injure the health of these costly objects. Tamers profess the greatest disdain for the ferocity of lions, tigers and panthers. They, therefore, leave them their claws and teeth and do not put them to sleep.

Is this as much as to say that the pursuit of wild beasts offers no danger? Certainly not, with all due deference to my London dealer, whom I would now no longer believe, being better acquainted with the subject. The danger, aside from falls (which are always greatly to be feared), may come from an instant of weakness that paralyzes the tamer. This sometimes, unfortunately, happens. The animals immediately perceive that the motions of the man waver, become uncertain and no longer urge them on properly. Terror disappears from the brain of the beasts, instinct speaks and a tragic ending is almost inevitable. I admit, of course, that it is a question of untamed animals, of animals captured in a wild state, for those born in menageries are much less to be feared. Some writers, destitute of personal experience, have, on the contrary, claimed that the latter are more to be dreaded; but do you not see that tamers have every interest in propagating this little paradox? Although lions or other beasts raised in menageries have occasioned accidents, it is because their gentleness has been abused and their ears have been pulled a little more than necessary. It is certain that training renders animals particularly gentle.

For want of these home-born animals, which are always in demand, and bring a high price, tamers as a general thing select a subject worn out by age or brought to terms by terrible rheumatisms, and, thanks to it, they can add to the pursuit over bars, through hoops and amid the sparks of rockets, and for sensational poses, such, for example, as the introduction of their heads into the jaws armed with formidable teeth. There are examples, very rare it is true, of tamers who have succeeded in coaxing young healthy animals captured in a wild state, and at first ferocious. This is the most perilous, most difficult and most unpromising method, and so it is very rarely employed. From this point of view, I could not too strongly urge you to pay a visit to the lions of the tamer Juliano. You will see that his large lion has the appearance of lying down in order to please him and shows the greatest possible regard for his master. This is because Mr. Juliano knows how to make his animals love him. It has even been told me that he made his debut in the profession in attending to a wounded lioness, which, having been saved, attached herself to him forever. He appears to us, at all events, to have the power of bending the will of his pupils, and this may be judged of from Figs. 1 and 2.

The training of wild animals is a relatively recent innovation.

In order to succeed in making large wild animals execute complicated exercises, it is necessary to act directly upon them, to handle them like dogs by putting them in a host of fatiguing positions, and that, too, with implacable insistence. Now, the mildest of the inmates of menageries would certainly not lend themselves to such familiarities. The trainer will therefore resort to a ruse. He will act like "tooth pullers," and put his animal to sleep by means of a narcotic, and during its sleep he will put on its neck a training collar provided with a strong chain, upon its nose a truncated cavesson forming a muzzle, and upon its legs strong shackles; and, finally, he will make it impossible for the animal to do any injury. It will, therefore, awaken vanquished. Then the trainer will patiently teach it by coercion the exercises that he wishes to make it execute. . . . .

Fig. 3.—LION STANDING UPRIGHT ALONGSIDE OF HIS MASTER.

It is in this way that lions have been broken in to equestrian voltige, that they have been taught to leap

from the saddle cushion of a horse upon a bridge under which the latter is passing, and then to jump upon the cushion again after the horse has taken a turn around the ring. It is in this way that the same motions have been taught to a tiger, that lions have been made to ride specially constructed tricycles, and that a tiger has been made to stand in equilibrium upon a ball and then to roll it along a rail, etc. This latter exercise was performed in the arena of Hagenbeck at the Chicago Exhibition, and we were enabled to obtain an instantaneous view of it (Fig. 1).

Let us reveal two more ingenious processes of animal trainers. In order to get their pupil to lick their head, they impregnate their hair with meat juice; and so too they make them fire a pistol by attaching a piece of raw meat to a string that controls the trigger. Hyenas and wolves are quite easily tamed, and obey almost like dogs, but it is from brown bears especially that interesting work is obtained. A ring is often passed through the cartilage of their nose, and the least blow given the chain that is attached to it renders them compliant and obedient. However, some trainers no longer employ this old method, but use the training collar, and chastise with the fist. The bear requires as many rewards as blows, and the reward indicated is a piece of honeycomb. Being a plantigrade, he walks uprightly very easily, waltzes in holding a stick, mounts upon a cylinder, fights admirably and performs many other exercises.

We have now passed in review the principal exercises of wild beasts. The tamers and trainers have, during the past four years, introduced into them a variety of changes that we had not been accustomed to. Still, they have not escaped grave criticisms. A number of persons think that it is perfectly absurd and even somewhat sacrilegious to make a lion ride upon a tricycle or upon a horse. I must confess that I do not take the royal mask of the lion so seriously.

The few exercises that I have just made known show us that it is possible to obtain from wild animals everything that we desire of them.—P. Hachet Souplet, in La Nature.

THE NATIONAL OBSERVATORY AT PARIS AND THE ASTRO-PHYSICAL OBSERVATORY AT MEUDON.

BEFORE the building of the model observatory at Nice, through the kindness of the banker Bischofsheim, the one at Paris held first place among such institutions in France, and in it worked such men as Cassini, Lalande, Mechain, Bouvard, Arago and the immortal Le Verrier, to whom science, and more particularly mathematical astronomy, owes so much. At first it was considered a model, but more from an architectural point of view than because of any special adaptation to scientific research. Epoch making discoveries have been made there, particularly under the régimes of Arago, Lalande and Le Verrier, although Arago did call it an "observatoire de parade," and Cassini tried in vain to convince the architect Claude Perrault that there were faults in his plans in spite of the fact that they presented a beautiful whole, architecturally speaking. It was built at a time when astronomical science stood on the threshold of a new period, leaving behind old untenable conditions, and as no observatory had ever been built on so extensive a scale before, the builders could not benefit by the experience of others, and the result of their work was really most creditable, in spite of its faults.

New instruments were invented, the telescope was continually improved, and this, like other observatories, underwent many improvements and changes to enable it to increase the accuracy of its work. The instruments provided were very fine, and these and the discoveries of Le Verrier won for the observatory a most enviable reputation.

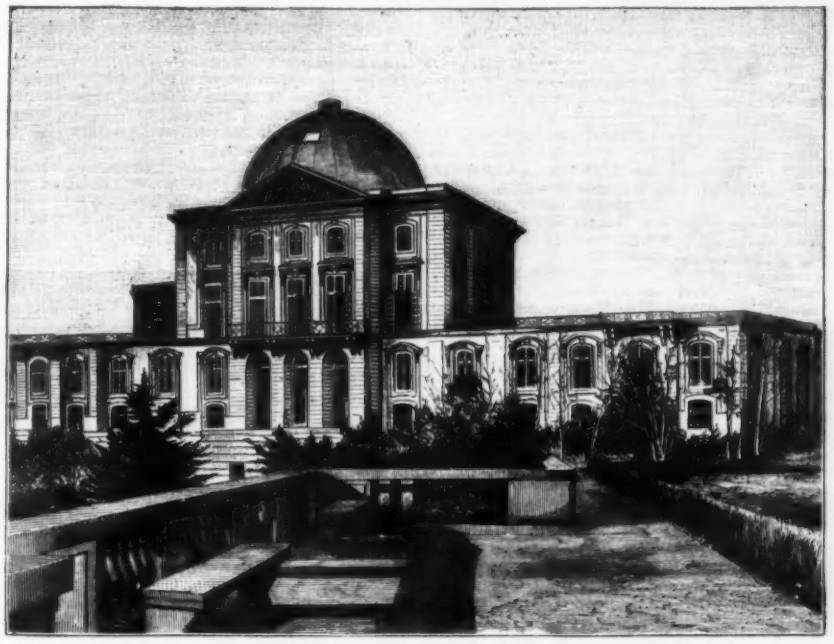
In the accompanying engraving we give a view of the south part of the building. The north front faces the beautiful Avenue de l'Observatoire that leads directly to the Jardin and the Palais Luxembourg, which are not far away. Upon entering the building we pass through the large hall, with its beautiful staircase leading to corridors by which we can reach the museum and offices of the observatory. The extreme west wing contains the dwelling of the director and the rooms devoted to observations, while the transit instruments and the meridian circles are in the east wing. The central portion of the building contains a large hall, with the library, from which passages lead to the various other rooms and the museum. Above the observation rooms are the mathematicians' rooms, the laboratories and the storerooms. On the east and west corners of the south front there are domes for the two equatorials, while a shelter has been erected in the garden for the great reflector, the meridian circle given by Bischofsheim, the little equatorial devoted to photographic work and the knee-shaped refractor, which is a celebrated specialty of this institution.

The observatory, with its garden, is shut in by a wall and a hedge, a relic of former times which is now entirely superfluous, for, of course, the smoke and vapors always rising from such large cities and so detrimental to scientific observations, cannot be walled out, nor can the light of the electric suns, gas lamps and other lights used in the streets nor the fogs and steam that hang over the Seine. It is probably on account of this fatal atmosphere that Neptune, the position of which was so accurately calculated by Le Verrier, was not discovered from Paris. It is even said that it is impossible to see all of the satellites of the great planet from Paris. The Paris observatory shares the inconveniences caused by an impure atmosphere with all others that have been erected near large cities, but they are probably magnified and intensified here.

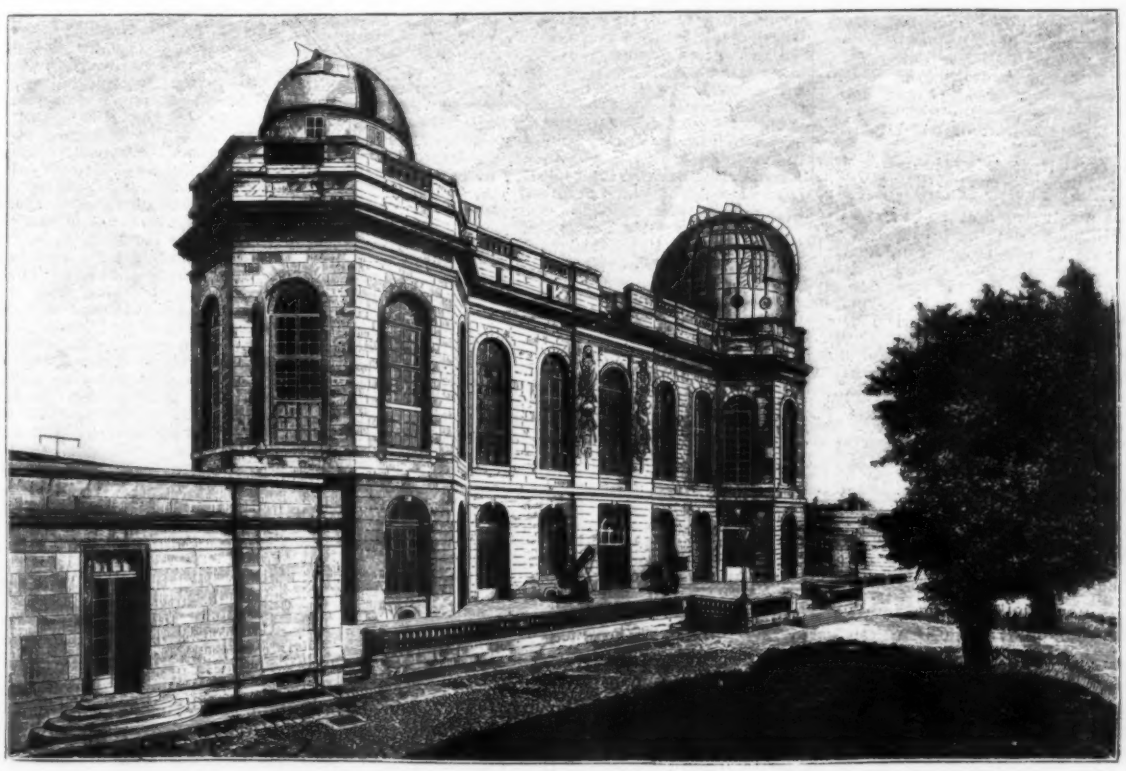
Another great source of trouble is the constant vibration due to the incessant passing of all kinds of vehicles through the busy streets of the neighborhood. The effect of the vibration is increased by the proximity of the old catacombs under Rue Denfert-Rocherau. It will easily be understood that this must cause trembling and swinging of the equatorials and other instruments, giving rise to a whole series of unfavorable conditions from which observatories should be saved at any price, for otherwise the results of observations which often require weeks for their completion will, to say the least, not be exact.

The situation of the observatory at Nice is much more favorable, as it is on a hill and is entirely isolated from the city. But in spite of all the difficulties with which they have had to contend, the director and the astronomers of the Paris observatory have earned an unsurpassed reputation by their work, their interest in all connected with their profession and their publication of the "Memoires et Annales."

As a natural consequence of this most unfortunate state of things, there has been talk of removing the observatory to a more suitable location, and the first step in that direction was taken by the establishment in 1886 of the Astronomical-Physical Institute at Meudon, in the department of Seine-et-Oise, which is thoroughly equipped for general astronomical work, but more especially for astro-physical observations, for this observatory is intended principally for a close study of the physical peculiarities of the stars by means of photography and spectroscopy. The first thing done at Meudon was to take photographs of the sun and study its spectrum. When the building was ready the personnel was not complete, but the director, the celebrated astronomer J. Janssen, undertook to make observations of the sun, its photosphere and its chromo-



THE ASTRO-PHYSICAL OBSERVATORY AT MEUDON.



THE NATIONAL OBSERVATORY AT PARIS.

sphere, and it is said that specialists who had an opportunity of seeing his photographs pronounced them perfect.

Objections had been raised to the founding of the institute on the ground that similar institutions already existed in other countries, but the movement received an impulse from the desire to complete the work begun by French observers—with Prof. Janssen at their head—in Siam at the time of the eclipse of the sun in 1875, and in Japan at the time of the transit of Venus in 1874. The final carrying out of the plans for the establishment of this observatory was due to Prof. Janssen, whose perseverance was untiring. The work was attended by many difficulties, especially in the selection of a proper site, for it was absolutely necessary that the institute should be located where the atmosphere was pure and the buildings would not be subject to vibrations of any kind. Prof. Janssen already had instruments that had been tested in work of this sort, and his photographs of the sun promised excellent results. Finally it was decided to take the almost unused palace at Meudon, from which there is a beautiful view of Paris and the valley of the Seine, and the building was immediately altered to adapt it to the new use. The dome for the great refractors was erected over the central part of the building, and the extensive stables were remodeled so as to be used for physical, chemical, and photographic laboratories. The park was, of course, most useful. The institute can be reached from Paris by means of the St. Lazaire Railroad, which runs frequent trains to the station at Meudon, about ten minutes from the observatory. The trip by the Seine steamer takes a little longer.

Among the most important instruments of the Meudon institute we might mention the great photographic a refractor, with an objective of 31 inches, and the little equatorial, which has an objective that is 24 inches in diameter. These two instruments have the same focal length of 52 feet 5 inches, and there are proper photographic correctors for both, for the smaller refractor can also be used for photography. The institute also possesses a concave silver mirror 3 feet 3 inches in diameter. The most remarkable thing about this telescope is its short focal length, 9 feet 10 inches. Short focal lengths of the refractors and more particularly of the reflector are most useful for photographic and spectroscopic purposes, especially when small objects or those that have only a feeble light are to be observed.

The chemical and physical laboratories are well equipped with all necessary instruments; the former stables forming the side wings of the building afford ample room for the pressure tubing, of which a total length of 328 feet have been put in. Tubes measuring from 19 inches to 198 feet serve for the observation of the spectra of confined gases under high and under low pressure, and for the solidification and the liquefaction of the gases. At Meudon the spectra of artificially solidified gases under a pressure of 20 to 100 atmospheres have been obtained. The great scientific value of these experiments as an aid in the discovery of the composition of fixed stars in general and of our sun in particular will be readily understood.—Der Stein der Weisen.

[Continued from Supplement, No. 1082, page 17299.]

PRECIOUS STONES.*

By Prof. Henry A. Miers, M.A., F.R.S.

LECTURE II.

Having seen how precious stones may be distinguished by means of their density, we can next consider how the optical properties may be used for purposes of identification. Here, as with the specific gravity, it is possible not only to make accurate numerical or quantitative measurements, but also to apply simple comparative or qualitative tests. One of the most important quantitative tests is that of the refractive power.

To determine with accuracy the refractive power of a transparent mineral it is usual to cut out of it a prism with a pair of smooth polished faces inclined to each other at an angle of about 60°, and to observe the course of a beam of light across the prism through these faces. This is done by means of a goniometer, an instrument consisting of a graduated circle with an axle on which the prism can be fixed in any desired position; of a "collimator" tube having at one end a slit through which the light falls upon the prism after passing through a lens at the other end; and of a telescope by which the slit may be viewed through the prism. The graduated circle renders it possible to determine the angle between the axis of the collimator and the axis of the telescope, that is to say, between the direction of the light as it falls upon the prism and its direction after refraction through the prism. The refractive power is measured in the following way:

Both the prism and the telescope are turned about until the angle between them is as small as possible, the illuminated slit being kept in view through the telescope, and this angle—the least angular deviation which the light can experience in its passage through the prism—is read upon the circle. If this angle be D, and the angle between the two prism faces be A, the refractive index, which is taken as a measure of the refractive power of the mineral, is given by the simple expression:

$$\frac{\text{Sin } \frac{A + D}{2}}{\text{Sin } \frac{A}{2}}$$

The angle, A, is easily measured with the same instrument.

The goniometer enables one at the same time to measure the dispersive power, for if the refractive index for one color be different from that for another, the image of the slit for violet light is formed at a different place from the image produced by the red rays. Hence, with the mixed light of day a spectrum will be seen extending from the one point to the other; but, by using light of a single color, a clear and simple image of the slit will be seen in the telescope, and then the corresponding index can be measured. The "dispersion" is measured by finding the refractive index for blue light and also that for red light, and subtracting the one from the other.

Such a method for measuring the refraction and dispersion seems at first sight quite unsuited for ordinary use, since it involves the preparation of a prism, and we cannot sacrifice a piece of any jewel for this purpose. But in reality the method is easily applicable to faceted stones if they are unmounted, for in these the lapidary has virtually supplied us with an appropriate prism, ready cut and polished. It is generally possible to find among the facets of a cut stone two which are inclined at a convenient angle, and to make use of these for our prism. The remaining facets may be covered with paper or blackened with ink so that the beam of light whose deviation is measured has only passed through the two chosen facets.

As a qualitative test the refractive power may be very conveniently measured by the method of total reflection. For this purpose a little instrument called the "reflectometer" is used; a tube carries at one end a hemisphere, B, of dense glass, with its plane face inclined obliquely to the axis of the tube; this is illuminated from above through an aperture, C, and is viewed (E) through an eyepiece at the other end of the tube; on the eyepiece is engraved a vertical scale.

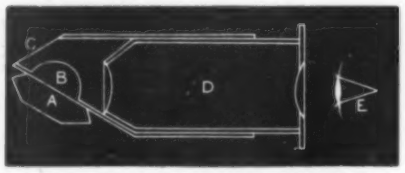


Fig. 4.—THE REFLECTOMETER.

The instrument is held in one hand, and the flat surface of the hemisphere having been moistened with a drop of some highly refracting liquid, a smooth facet of the stone, A, is pressed against it. On looking into the eyepiece two faint shadows are seen crossing the field of view; one of these (at, say, the 38th division of the scale) occupies the same position whatever stone is being examined, while the other crosses the scale at different points for different stones; suppose it be 22 for the particular stone under examination. These shadows are caused by total reflection; light falls upon the flat side of the hemisphere at all inclinations and reaches the eyepiece with different degrees of brightness, according as it has been totally reflected or not.

The part of the scale beyond 38 (in the particular instance which we have chosen) corresponds to light which has been totally reflected from the liquid at the surface of the glass; it is perfectly bright; below 38 the light which enters the eyepiece has passed through the film of liquid, but has been totally reflected at the surface of the crystal for all that portion of the scale which lies beyond 22. Below 22 very much less light enters the eyepiece, for it has been partly refracted away through the crystal; that portion of the field is comparatively dark, giving rise to the appearance of a shadow. We have only then to graduate the instrument, by examining a number of minerals of known refractive index and noting where the shadow crosses the scale for each, and then when we come to examine any new stone we can at once say, by the position of the shadow, what is its refractive index, and therefore whether it is a topaz, tourmaline, beryl, or other mineral. You will remember that total reflection only takes place when light passes from a more refractive to a less refractive substance; if, therefore, it is to take place at the surface of the stone where the light strikes it on leaving the liquid, the stone itself must have a less refractive power than the liquid. For this reason the method can only be applied to those minerals whose refractive index is less than 1·66 (the greatest index of refraction yet obtained in any transparent liquid); that is to say, those that lie above spodumene on the diagram; those with a higher index of refraction give no shadow at all. Until a more highly refractive liquid is discovered the other gem stones cannot be examined with the reflectometer, but for any stone the instrument at once shows whether the refractive index is greater or less than 1·66.

We must now pass to a class of wonderful optical properties which are absolutely peculiar to crystals. These properties depend upon the fact that all the precious stones except diamond, spinel, garnet, and opal are "doubly refracting."

When a ray of light falls upon a doubly refracting crystal, it becomes divided into two distinct rays which travel in different directions within the crystal. For this reason any object viewed through such a crystal appears double. Iceland spar is the mineral which is most strongly doubly refracting.

The double refraction is best measured by the goniometer. Just as we found that the dispersion of a crystal produces with white light a band of colored images, so will its double refraction produce, even with a singly colored light, two distinct images of the slit when it is viewed through the telescope across the crystal.

To each of these images corresponds a refractive index; consequently, when we attempt to determine the refraction of any precious stones we find not one but two refractive indices; the double refraction is measured by their difference. Diamond, garnet, and spinel are the only crystallized precious stones which have single refraction; thus the two refractive indices for zircon are 1·970 and 1·920, so that the double refraction of zircon is expressed by the number 0·050 or fifty thousandths. The double refraction of Iceland spar is no less than 172. The double refraction or "birefringence" of each mineral in thousandths is given after its name in the diagram, Fig. 3.

The "O" after diamond, garnet and spinel signifies that they possess single refraction, having only one refractive index.

Not only does a doubly refracting crystal give two images, but unless the crystal is white, the two images are themselves differently colored and the colors are more or less characteristic of each stone. This property is known as "pleochroism," and it is observed by a little instrument called a "dichroscope." (Fig. 5.) This consists simply of a tube having a small aperture at one end and at the other a lens which is focused upon the aperture; the tube contains a piece of Iceland spar (calcite). The gem stone, A, is held in front of the aperture and is viewed through the lens.

By this contrivance the two beams of light produced by the crystal are more widely separated by the Iceland spar, and give rise to two colored images of the aperture, which are seen side by side, and can be easily contrasted. The minerals which show the most characteristic colors are ruby, sapphire, tourmaline and cordierite, or water sapphire, as it is sometimes called.

A further peculiarity of the light which has passed through a doubly refracting crystal is that it is polarized. Without attempting in the short time at my disposal to explain the nature of this polarization, I may show upon the screen the curious effects produced by a gem stone when it is observed in polarized light. The instrument used for this purpose is the polarizing microscope, or polariscope; it consists of a tube carrying at each end a double piece or prism of Iceland spar, so constructed as to convert any ray of ordinary light which falls upon it into a single ray of polarized light, instead of the usual double ray. In the center of the tube, upon a little microscope stage, the stone is placed, and upon each side of it is a lens like a large microscope objective, which concentrates the light upon it in all directions. Owing to its own double refraction, the stone imparts to the light that passes through it a tint which depends upon the direction of the rays, and the result is a colored pattern of a curiously regular geometric shape. This tinted pattern, which is called an "interference figure," consists of curved bands of spectral colors, and it may be of two sorts.

Fig. 5.—DICHROSCOPE.

Some stones give rise to a set of circular rings intersected by a black cross; they are known as "uniaxial" minerals. Others give rise to a set of oval rings surrounding two centers which are the apices of the two branches of a black hyperbola; they are known as "biaxial" minerals. Garnet, spinel, diamond and opal possess no double refraction, and therefore do not give rise to an interference figure at all.

It is stated on the diagram (3) in each case whether the mineral is uniaxial or biaxial. The interference figure gives still more information about the birefringence, for, if the rings are narrow, they indicate strong double refraction; if they are broad, the double refraction is weak.

Crystals are further distinguished as positive and negative, according as a test crystal when placed in a certain direction over the stone which is being examined has the effect of adding its double refraction to that of the stone or of subtracting its own double refraction from that of the stone. The test crystal used is a thin film of mica in the case of uniaxial minerals, and a thin wedge of quartz in the case of biaxial minerals. The effect of the test crystal is shown by the expansion or contraction of the rings in the interference figure.

[The distinction between positive and negative, uniaxial and biaxial, etc., was shown in a number of crystal sections, whose interference figures were thrown upon the screen by means of a projection polariscope.]

All these properties can be determined with a faceted stone, provided that it is unmounted.

There is a difficulty connected with the interference figure of a faceted stone that with an inexperienced observer is almost fatal. In order to see the interference figure, the stone must be turned into the appropriate position, and it may happen that the stone is so faceted that in this position one is looking at a pointed corner, and cannot see through it; just as we saw that the light could not penetrate a faceted aquamarine when it fell directly on the surface. This will be due to the fact that the emerging light is refracted away, or is totally reflected within the stone. The difficulty, I find, can always be surmounted by immersing the stone in some liquid of high refractive index, such as glycerine or oil, or bromonaphthalene contained in a corked tube. Light passing from the liquid into the stone suffers little refraction; it travels through the stone, and the interference figure can be easily seen.

[This was shown by placing a faceted topaz in the lantern, when it appeared opaque upon the screen. On immersing the stone in oil it at once became transparent.]

There are two other characters not connected with light, but peculiar to crystals, which are of some value for the identification of precious stones. One is the cleavage—the tendency of a crystal to split along certain smooth plane surfaces.

Diamond splits in such a way that it can be cleaved into an octahedron; a property useful to the diamond cutters, since it enables them, without the great labor of grinding, to split the stone into something of the shape and size of the brilliant, before it is put upon the lapidary's wheel.

Topaz possesses an equally marked cleavage, but in one direction alone; a glittering surface due to the splitting of the stone in this direction can almost always be distinguished upon the edges of a rough topaz—and faint cracks due to the same cause can often be seen inside a faceted topaz, even though it be almost absolutely free from flaws.

Another still more startling property possessed by certain crystals is one which among precious stones belongs to the tourmaline alone. A crystal of this stone, whenever it is being warmed or cooled, becomes electrified; it becomes positively electrified at one end and negatively at the other. The effect is not very strong and it might be imagined impossible to make use of this curious property for the identification of the mineral. But it can be used by virtue of an ingenious device lately invented for making such electric charges visible to the eye.

* Lecture delivered before the Society of Arts, from the Journal of the Society.

Take a mixture of finely powdered red lead and sulphur, and dust it through a muslin sieve on to a crystal of tourmaline, which has been warmed over a spirit lamp and is cooling. Instead of lying as an orange powder uniformly distributed over the crystal as it would be over any stone without an electric charge, the powder becomes separated into its constituents, the red lead flies to one end, the sulphur to the other; the one end is seen to become red and the other yellow. This is because the red lead and the sulphur electrify each other by friction in passing through the sieve, the sulphur becomes negatively and the red lead positively electrified; unlike electricities attract each other, so that the sulphur flies to the positive end and the red lead to the negative end of the crystal. Being held by electric attraction, the powder cannot be easily shaken or blown off, as it would be from an unelectrified crystal.

This closes the list of properties which are practically useful in the discrimination of precious stones. As an example, I may summarize the various tests which we might apply to a rough topaz and a faceted tourmaline respectively.

The rough topaz will be seen, if carefully examined on its edges, to show traces of cleavage in one direction in the shape of little smooth, flat surfaces; a small chip broken off will show this even more clearly. It will be a flake.

This flake dropped into methylene iodide will sink, showing that it has a specific gravity higher than 3·3. The same flake placed in the polariscope will give a biaxial interference figure, and the use of the quartz wedge will show it to be positive. The breadth of the colored bands indicates to an experienced eye that the double refraction is not strong.

By means of the total reflectometer both the refraction and the double refraction may be accurately measured; two shadows will be seen to cross the scale—one at the number corresponding to the index of refraction 1·63, the other to 1·62; the double refraction being the difference between these two is 0·01, or about ten thousandths.

Examined with the spectroscope, the crystal gives no absorption, and is therefore neither zircon nor almandine garnet.

If it be desired to find the specific gravity, the fragment can be dropped into the thallium-silver nitrate, which is then diluted with water until the fragment just sinks. A little further warming will drive off a trace of the water, and the fragment of the stone will remain suspended. Test fragments of other stones being dropped into the liquid, some will float and some will sink, but a piece of topaz will do neither. We have already, however, obtained such convincing evidence from the optical properties alone that it was not necessary to pursue the investigation so far. Its refractive index alone was sufficient to distinguish it from chrysoberyl, the only stone with which it might be confused by its position on Fig. 3; and the whole determination may be made on a fragment about the size of a pin's head.

Take next our faceted tourmaline. If it is not mounted in a setting, the specific gravity can be easily found to be exactly 3, or that of a test piece of tourmaline, by means of the methylene iodide, in which it floats until the liquid has been slightly diluted with benzene.

Pressed against the reflectometer, the shadow at once appears on the division of the scale corresponding to an index of 1·63. Examined in the polariscope it is seen to be uniaxial and negative. These three observations are enough to determine the mineral with accuracy.

Further, in the dichroscope, it shows a most pronounced difference of colors, far more striking (if the stone be a brown tourmaline) than that shown by any other mineral. Even if it be mounted in a setting, the refractive index, as determined by the reflectometer, fixes its position on the scale diagram (Fig. 3) in the neighborhood of diopside.

But take the tourmaline, warm it, and dust it with the mixture of red lead and sulphur—the electrification at once shows it to be a tourmaline. This test I have frequently applied and have never known it to fail; it serves to distinguish tourmaline with certainty from diopside, with which it might easily be confused; there are several other stones with which it might be confused on account of its wide range of color, with spodumene for example, or axinite, epidote, or idocrase. I have certainly known tourmaline sold as all these minerals. Their superior brilliancy is generally sufficient to distinguish either spinel or ruby from a red tourmaline. In fact, the refractive index of tourmaline is so much less than that of any stone which it resembles that the reflectometer at once identifies it. The other minerals have a refractive index greater than that of the bromonaphthaline, and give no shadow in the instrument at all.

Take again any other pair of stones which are liable to be confused, garnet and ruby for example. A glance at the diagram will show how they are to be distinguished. The specific gravity will scarcely suffice, but ruby is uniaxial, negative, and has a double refraction of $\frac{8}{1000}$, whereas garnet is generally singly refracting, and even if it does show a weak double refraction, will never give the uniaxial figure.

Take again the true jacynth, which is a brown zircon, and the false jacynth, which is a brown garnet, both the high refractive index and the strong double refraction as well as the high specific gravity distinguish the zircon at once; and by the same characters a colorless zircon is easily distinguished from a lux sapphire, which it very closely resembles. But in reality a mere glance at the stone through a spectroscope will identify it if it be a zircon; the characteristic bands in the spectrum can not be given by either a sapphire or a brown garnet.

There is a curious and widely prevalent confusion between olivine and the beautiful green garnets found in the Ural Mountains; the latter are almost invariably known in the trade, and are sold, as olivine.

Now, olivine is biaxial and possesses a strong double refraction; the garnet, on the contrary, is almost, if not quite, free from double refraction. There can be no possible similarity between the two stones except as regards color, but there is a popular prejudice against garnets, and I suspect that this largely accounts for the selling of these stones under a wrong name.

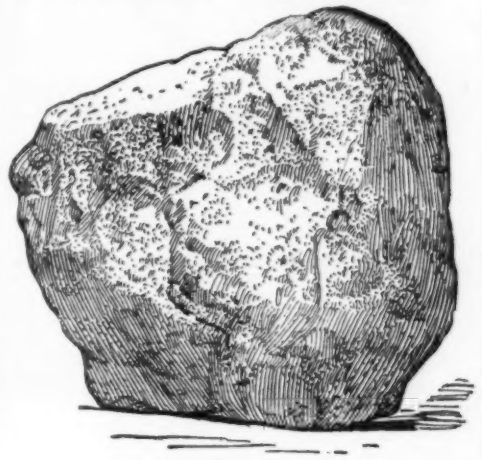
Most important of all distinctions is that between any true gem stone and its imitation in glass or paste. In this matter there are simple tests which need never fail. Precious stones are imitated with great skill; compositions are made, which not only resemble the true stone in color, but by the use of lead glass and other dense compounds they may have as high a refractive index as some of the stones and as great a specific gravity. But you will never find that both the refractive index and the specific gravity are those of the true stone. The imitation will not find a place in our diagram scale. Again, the imitations are not ever so hard as the true gem stones; they can be scratched with a knife. But the most important and an absolutely infallible criterion is the fact that the imitations are not crystals at all, and can never show the double refraction or the dichroism of the doubly refracting jewels.

I may mention that it has just been stated by a French observer that the newly discovered X rays afford means of distinguishing between certain gems and their imitations. True ruby, or sapphire, or true turquoise are like flesh—transparent to the X rays; but their imitations are like bones—opaque to them.

There is, however, one totally different class of artificial jewels which have only recently come into existence that must be considered quite apart, namely, true crystallized gem stones produced by artificial means. Innumerable have been the attempts to manufacture true diamonds, and at length they have been crowned with success; by more than one process diamonds have now been manufactured—most successfully, perhaps, by the method of M. Moissan, who, by the intense heat of the electric furnace, dissolves charcoal in molten iron, and by cooling under pressure, induces it to separate out as crystallized carbon or diamond.

It is quite possible that we have here a reproduction of the actual process by which diamond has been produced in meteorites. It may not be generally known that some of these curious pieces of iron and stone which come to us from outer space have been found to contain true diamonds.

Moissan's diamonds are mere minute specks, and by no means clear and limpid; moreover, they are costly to produce, so that there is little or no fear of their entering into competition with the diamonds of Kimberley. But quite otherwise is it with the ruby; this stone has now been successfully reproduced in Paris, and on a sufficiently large scale to be used in jewelry. The ruby has been made in several ways. (The result of one of the methods employed by M. Frémy was shown by a diagram.) The crystals were made by raising to a very



THE BIG CARBON.

high temperature a mixture of alumina, potassium carbonate, and calcium fluoride. The red color is obtained by adding a trace of potassium chromate. By maintaining the temperature for about a week, crystals weighing one-third of a carat were obtained without great difficulty.

Now, these stones cannot be distinguished from the natural ruby by any of the tests which I have described. They possess the specific gravity, the refraction and the double refraction of the natural stone; in the polarization they show the same uniaxial interference figure; In this there is no cause for surprise; the artificial stone exhibits the same characters as the ruby, for the simple reason that it is a ruby. Other minerals have been reproduced by artificial means. Turquoise has been successfully made by compressing powdery artificial phosphate of aluminum into a compact mass.

Prof. Judd has kindly lent me two sheets of paper covered with blue paint; one of these is painted with natural ultramarine, the other with artificial ultramarine. You see that one is as good as the other. So also with the ruby, I can see no reason why it should not ultimately be made as large and as beautiful as any natural specimen; the attempts to reproduce sapphire have not been so successful as regards color, but here, again, I see no reason to doubt the possibility of excellent sapphires being ultimately manufactured.

Large numbers of artificial rubies are now used in jewelry. The only respect in which they differ from the natural stone is that they have been formed by a different process.

If we desire to distinguish them, it can only be by some feature resulting from the manner in which they have been made. From my own limited observations, I think it is generally possible to see in the artificial rubies, by means of the microscope, a certain streakiness and also little cavities like bubbles, which one does not see in the natural stones. Both these characters may be due to the relatively high temperature at which the artificial stones have been formed, and the comparatively short time in which they have been produced.

In bringing to a close these imperfect and fragmentary notes on precious stones, I must call attention to the chief point which it is my desire to emphasize. I have indicated how I should myself set to work to determine the nature of a precious stone. Each observer can use his own contrivances, but they must be in accordance with the principles which I have illustrated. The methods are those of physical science—and they are accurate; personally, I should hesitate to assert positively the nature of any precious stone except by means of the scientific tests, although I might have an opinion. It may be my own want of expert knowledge which prevents me from feeling confidence in any but these methods: at any rate, I claim for them that they enable any one with a little practice to determine with absolute certainty any precious stone, even when it is faceted, and moreover, they supply, not an opinion, but a proof.

Considering the number of serious mistakes which are made in the trade, and the curious errors which prevail, jewelers would surely do well to learn these methods; to acquire especially such a knowledge of crystal optics as will enable them to determine the refraction and double refraction of any transparent mineral. A simple microscope, such as geologists use, is all that is necessary for the purpose.

It would be, I imagine, desirable for every large firm which deals in precious stones to engage the services of an assistant possessed of sufficient scientific knowledge to make these determinations, for precisely the same reasons which make it desirable for large manufacturing firms to engage the services of a scientific chemist.

The absolute necessity of accurate scientific knowledge in commercial and practical undertakings is now fully recognized.

The jeweler's trade stands almost alone in failing to realize that such knowledge has a real commercial value and in ignoring the aid of physical science. I need not point out that some such knowledge is even more important for those who buy than for those who sell precious stones.

I hope that the effects shown upon the screen to-night have made it abundantly clear that precious stones have a great deal more in them than is at first sight apparent, and that, like all other natural objects, they disclose more and more features of beauty and interest the more closely they are studied.

In the present lectures I have shown or described certain effects without a word of explanation. My object has only been to indicate how, in one respect, the mineralogical researches relating to the physical properties of crystals have a direct practical application, although they were undertaken in the pure spirit of scientific curiosity. In this they resemble all researches of abstract science.

In conclusion, I would add that those who care to carry the study a step farther than we have done to-night, and attempt to explain all these curious properties, will find themselves in a most fascinating field of discovery and speculation, which has proved attractive to many of the acutest intellects of the present century.

THE LARGEST DIAMOND.

THE Sun presents herewith a picture of the biggest diamond ever found. The picture is reproduced the natural size of the big stone, from a photograph recently sent to this country from Paris, where the diamond was sent to be sold.

The accuracy of the picture is vouched for by Benjamin M. Levy, a diamond buyer and dealer of 68 Nassau Street, New York City, who was the first American to see the wonderful stone, and perhaps the only American who has seen it.

Mr. Levy saw and handled it in the wilds of South America, within a few miles of where it was found, and he tells an interesting story of his efforts to buy the diamond. He offered $17,500 for it, and the miner who found it wanted $50,000. Broken into fragments, it is estimated to be worth for mechanical purposes about $66,000. If the great stone were of the crystalline variety which we know as gems, which are known in the trade as diamonds, and of a good color and water, there would be no knowing what value it might have. It is seventeen times as big as the Victoria diamond, the largest of modern finds, and that stone sold for $1,500,000; but it is of the amorphous variety of diamond known in the trade as carbon, and its value is due purely to the use to which it could be put, when broken into small fragments, for furnishing cutting points for rock drills, saws for cutting rock or other refractory materials and for facing tools for turning hardened steel, emery wheels, and such hard things.

The uncrystallized black diamond is found only in the Bahia region of South America, and it is the hardest substance yet discovered upon the earth. Its powder will cut the crystallized diamond almost as easily as diamonds will cut the ruby, sapphire, and emerald.

The gem which we call the diamond has been known for many ages, but until the discovery of the diamond fields of South Africa the stones were comparatively rare in the world. One day in 1867 some one picked up a pebble in the Orange River near Hope Town, which proved to be a diamond. Then in 1869 the diamond known as the Star of the South was found. It weighs 83 carats and sold for $60,000. Since that time the mines in the blue ground country at and about Kimberley have been opened and the South Africa diggings now supply 98 per cent. of all the diamonds of the world.

On our side of the world diamonds were found in the neighborhood of Rio de Janeiro, in Brazil, in early days, and later the carbon workings in Bahia were found. Mr. Levy is a diamond buyer—one of a class of sharp, able and active business men who were developed when the diamond fields of South Africa were developed. Their business is to go wherever diamonds are found, provided with ready cash, and buy the diamonds at first hands purely upon their own judgment.

Many a gem found its way out of the mines in a mysterious way, and diamond buyers were always at hand to purchase these as well as the ones in the hands of the miners, although it meant death to be caught.

He began buying diamonds sixteen years ago, and he says that since that time he has made one trip a year to South Africa and five trips altogether to South America. It was during the trip which he made into the Bahia region, a year ago, that he saw the great carbon shown in the picture.

Going into the Bahia diamond region to buy carbons, Mr. Levy says, is by no means a pleasant job. The diamond buyer not only has to take all the risks from venomous insects, and wild animals, boa constrictors, and crocodiles, which the usual traveler does, but be

must also risk being murdered and robbed, for he must go provided to buy with ready money.

"From Canuaveiras we go to Jacreandor, and there we take mules to the diggings. When I first went in there, thirteen years ago, there were but fifty men at work. Now there are about 300. They find the carbon under about four feet of ground, in gravel. Sometimes it is stuck fast to bits of the other stones, as if it had been embedded in rock once, and some pieces have spongy places where bits of clear pebble seem to have been forced into the carbon. One's guide is supposed to know where all the mines are, and he introduces the buyer as a man with no end of money.

"I was among the mines," he said, "when I met an old guide of mine, Pedro Gonzales, coming out, bound for Bahia with the big carbon which had just been found. He showed it to me, and I tell you I was astonished. It was a solid piece, with only one little spongy place on its surface, and it was as big as a baseball. It weighed 3,083 carats. The biggest piece of carbon I ever saw before weighed 700 or 800 carats.

"'Do you want to buy?' he asked.

"I offered him £3,000 for it.

"'I'll sell it for £10,000,' he answered.

"I turned right round and followed him back to Bahia. On the way I raised my price gradually to £3,800, but he wouldn't sell. He took ship for Rio and I followed. Then he went back to Bahia and I was still on his track. Besides my own purchasing, I was authorized to buy for another house to the extent of £10,000 worth of carbon and had a draft for the money.

"I got to Bahia one night just a day behind Gonzales. He was gone, but I learned that he had sold the big carbon to a merchant there. I went to the merchant. 'It has gone to Paris by this morning's ship,' he said. I do not know what he paid for it."

Then Mr. Levy explained what would have to be done to prepare the big stone for market. The pieces in which carbon is of most value are in sizes ranging from 1½ to 3 carats. In these sizes it is worth at present prices about $25 a carat. It will take a ten ton hammer, he says, to break up the big stone and much of it would go to waste under the hammer, but supposing that the stone turned out 2,650 carats of good cutting stones, it would bring $66,250.

Mr. Levy says there is more carbon in this one stone than there is in the whole market outside of it, and that it is so scarce that the South African imperfect and flawed stones known as bort are being used in its place.

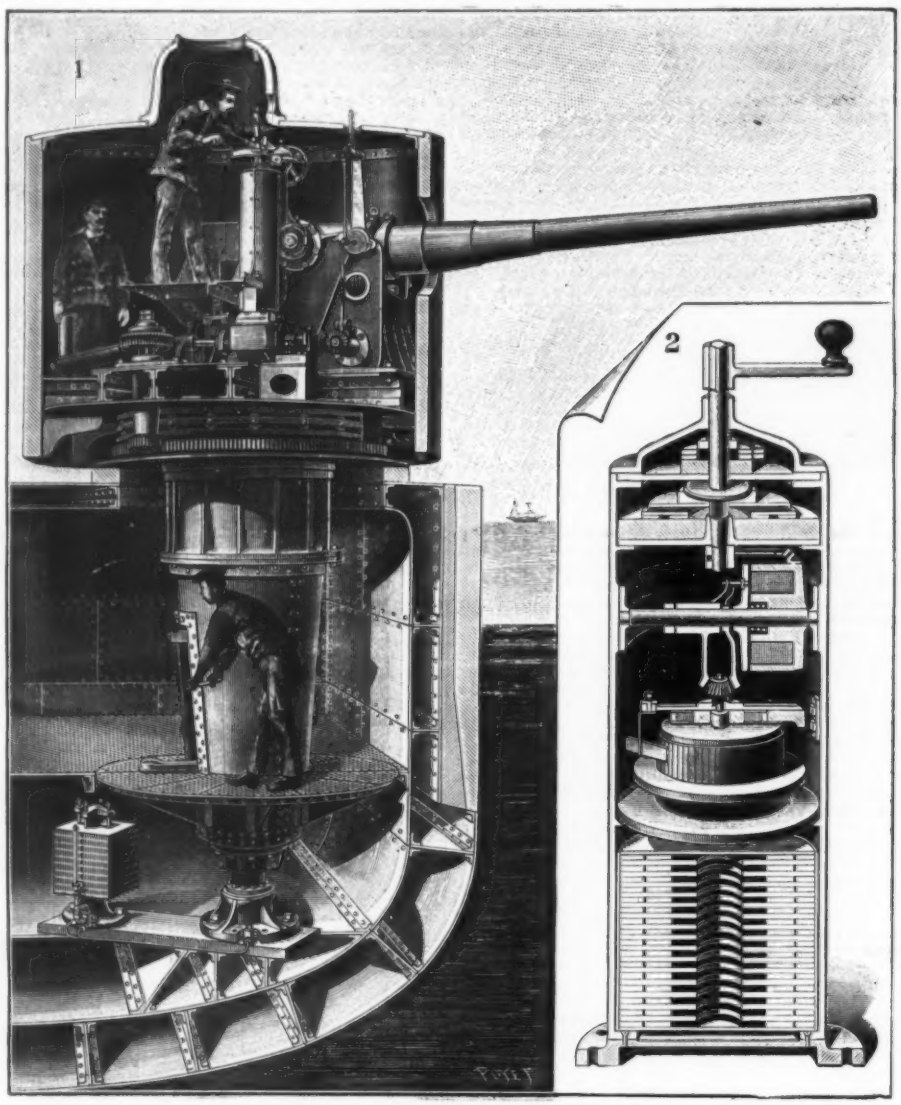
AN ELECTRIC DREDGER.

The accompanying engraving represents a dredger of novel construction, which has recently been built by Mr. A. F. Smulders, Rotterdam, to the designs of M. Bunau Varilla, and is intended for use on the river Esla, in Spain. The principal feature in connection with this dredger is that the motive force, in the form of electrical energy of high tension, may be generated on shore by any convenient means, the current being distributed either by overhead wires or cables laid under the water. In the particular installation under notice the central station is situated on the river bank, and furnishes current not only to the dredger, but also to work an elevator which returns the material dredged into lighters and ballast wagons. All the motions are controlled by one man in the cabin, shown. When once in position a heavy metallic pile situated on the central line abaft the chain is allowed to fall, and penetrates by its own weight the bed of the river, forming a pivot around which the dredger can be made to describe circles, the movement being effected by two screws situated near the bow, and operated by electric motors in such a manner that the boat may be rotated in either direction. When all the material lying in the circle of operations, of which the fixed pile is the center and the end of the bucket chain the radius, has been removed, a second pile at the stern, but not on the center line of the dredger, is allowed to fall, and the first one is raised. The second pile now forms the pivot around which operations are conducted, and it will be readily understood that when the necessary depth has been dredged, by dropping the first pile again when the boat has reached a predetermined position, a new area for dredging is reached. The winches for operating the bucket chain and raising the piles are operated by electric motors controlled in the cabin. The motor for operating the bucket chain is capable of developing 45 horse power when making 600 revolutions per minute, the reduction of speed being effected by intermediate pulleys and belting in the usual way. The average power required to work the dredger is equal to about fifteen horses, and as the motor is equal to 45 horse power in normal working, a good margin is left for emergency.

The dynamo machines chosen by M. Varilla are of the three phase alternating type, giving 2,000 volts, which pressure is transformed on the dredger to 200 volts. Besides operating the motors for driving the screws, driving the dredge chain, raising the dredge frame, and lifting the piles by electrical energy, there is also a centrifugal pump, which is worked by electric motor. We are indebted to the London Engineer for the cut and article.

ELECTRIC TURRET FOR ARMORCLADS.

Mr. Canet, engineer of the Forges et Chantiers de la Mediterranée, to whom is due a large part of the progress made in the installations of naval artillery, after taxing his ingenuity to devise hydraulic apparatus as perfect as possible for such artillery, was nevertheless the first to substitute therefor electric apparatus of still simpler management.

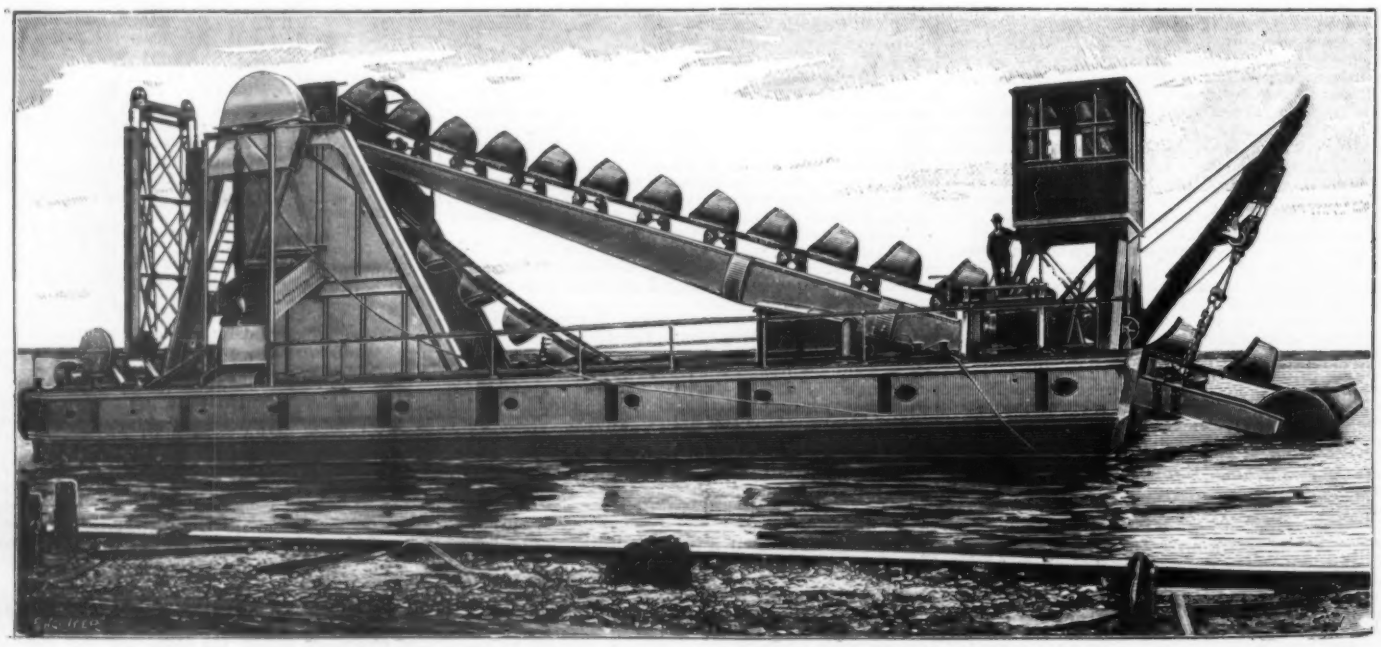


ELECTRIC TURRET FOR ARMORCLADS.

1. Section of the turret. 2. Regulating apparatus.

Let us briefly examine in what a Canet turret consists, and the manner in which electricity is applied to the maneuver of it.

The gun, which is the raison d'être of the entire installation, slides during the recoil in a collar which rests upon the pedestals of the carriage, and carries the cylinder of the brake. The gun, on the contrary, is connected with the piston rod, which moves in this



AN ELECTRICALLY WORKED DREDGER FOR THE RIVER ESLA, SPAIN.

cylinder in forcing through very narrow orifices a liquid whose resistance quickly exhausts the force of the recoil. At the same time a number of superposed Belleville springs are compressed, and, storing up this force of recoil, are ready to restore it, at the will of the chief gunner, in order to bring the piece into battery again.

The gun is protected by the nearly vertical walls of an armored turret, which is elongated in the rear in order to afford more space to the men, while its flat roof is surmounted by a dome-shaped hood designed to cover the head of the gunner. The armoring and the carriage itself rest upon an iron plate platform that revolves upon a ring of rollers, and that is carried on another hand by a conical shaft likewise of iron plate, which extends to the bunkers and terminates in a hydraulic pivot around which the entire system revolves. This shaft contains the elevator, which is a sort of noria whose buckets receive the projectile and cartridges and raise them to the loading platform. For rapid fire guns there are peculiar arrangements that permit, by this means, of making provision for eight shots a minute.

Two men, acting upon a winch and actuating a pinion that gears with a rack concentric with the platform of the gun, suffice to point the latter.

The electric manipulator, which takes up but little space, is, properly speaking, the controlling agent that transmits the will of the chief gunner or of the pointer to the different parts.

It will be readily understood that it is quite easy to regulate the velocity of rotation of the turret by the simple displacement of the handle of the manipulator, which introduces or suppresses resistances; and it will at once be seen that this mode of action has the advantage of being always sufficiently graduated and progressive, whatever be the abruptness of the opening of the current.

This suffices for the important movements that permit of quickly training the gun. It is necessary, besides, to be able to effect an abrupt arrest in the direction chosen. This again is obtained by a displacement of the lever, which breaks the current and at the same time unites the brushes of the machine in short circuit. The motor, thus converted into a generator, all at once opposes its own resistant work to the motion of the turret.

A special arrangement then permits of giving the turret very feeble motions to the right and left, in order to finish the pointing in direction.

Finally, in order to ward off abrupt shocks, it is well to assure the automatic stoppage of the turret at the two extremities of its travel, and this is effected by means of a magnetic clutch. This automatic device is indispensable for cases in which the pointer may be killed or wounded while the turret is revolving at full speed in one direction or the other.

The electric manipulator is not used for pointing in elevation, which is done directly by hand without much difficulty, thanks to the equilibrium of the masses to be moved; but it is likewise electricity that moves the elevator, through the intermedium of a friction drum.

Such is the general arrangement of this remarkable installation, which makes our great marine guns apparatus relatively easy to handle. The power necessary to develop in order to set them in action is not very great. For the 10 inch gun turret the motor for pointing is of 15 nominal horse power, but develops only 10 horse power in normal operation. The elevator absorbs 8 horse power. For the 5 inch gun turret the revolution requires but 3 horse power.—La Nature.

THE VALLEE GASOLINE CARRIAGE.

THIS carriage figured at the last Salon du Cycle, where it attracted much attention. It is strong and light and looks as if built for racing.

The frame is of cold drawn steel tubes strongly cross braced. It is capable of receiving any sort of carriage body with or without hood and apron. It is actuated by a light Vallée gasoline motor that produces no vibrations. In the carriage for two passengers the motor is of 2 horse power, and in that for four passengers it is of 4 horse power, and so on. This motor has two cylinders completely balanced and of velocities variable between 200 and 500 revolutions. The carriage may be run at four different speeds through gearings with special toothing that makes no noise. As the motor itself revolves at variable velocities, it is possible to obtain any speed between 3 and 15 miles an hour.

The lighting is electric. The carbureter, which is of a special type, is kept at a normal temperature through a circulation of the gas derived from the exhaust. As the motor is placed in the rear, the passengers are not annoyed by any odor.

The suspension of the front of the carriage is copied from the front forks of the bicycle. The steering tubes serve likewise as lamp supports.

Motion is communicated to the driving wheels through a sprocket and endless chain. To the right is seen the hand wheel for steering, and, grouped beneath, are observed all the levers for maneuvering and regulating the motor and changing the speed. This arrangement leaves the seat absolutely free, and permits the passengers to ride in comfort.

The carriage carries a supply of fuel sufficient for a run of sixty miles. It is provided with two brakes, one of them placed upon the driving shaft and the other acting upon the wheels and controlled by the foot. The wheels, which are analogous to those of a bicycle, are provided with the Vallée pneumatic tire, which is worthy of a description. Fig. 2 shows that it consists of a felly, H, formed of a light and rigid rectangular tube held between two plates (one of them, I, fixed, and the other, J, movable) and fastened by means of bolts. G is the air chamber, of pure Para rubber and much thicker than in ordinary pneumatic tires. D is a very resistant layer of canvas, which is coated with a special tar to prevent its rotting through humidity, and which is covered with a flexible rubber jacket, C, after fixing it by means of the steel rods, E, F. Leather is used in preference to rubber, because the best rubbers of slight thickness become dry and crack in the long run, while leather is capable of lasting indefinitely. To the jacket, C, is sewed an endless band of thick leather, B. Finally, the whole receives a protective armor, A, composed of juxtaposed steel plates riveted to the band of leather, B.—Locomotion Automobile.

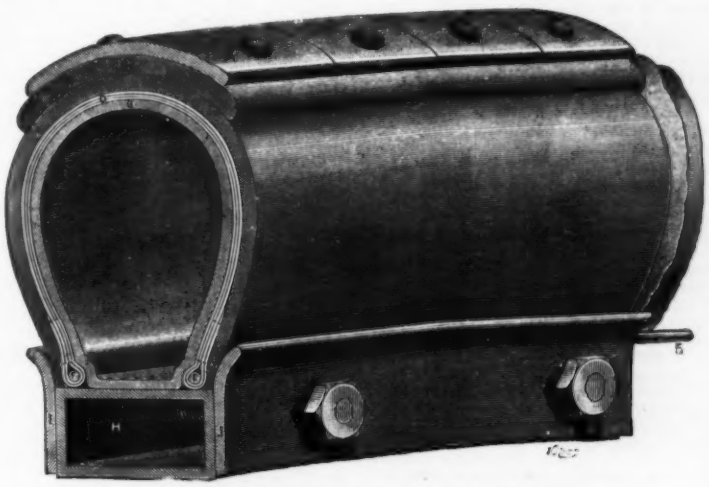


FIG. 2.—VALLEE'S PNEUMATIC TIRE.

THE ARTISTIC ELEMENT IN ENGINEERING.*

A FRIEND of the writer, a successful business man and much interested in things artistic, when informed of the choice of subject for this paper, gave expression to a feeling of surprise, doubting if there were any relation between engineering and æsthetics.

One of the leading engineers of America once asked a professional brother what he did for recreation, and on being told of a modest interest in pictures and music, likewise expressed surprise, saying, "You are the first engineer that I have ever known to be a musician." There was also an implication, though unintentional, of a diminished respect—perhaps on both sides.

These two incidents may be taken to typify in a general way the attitude that is held by the business world, on the one side, and the engineering fraternity, on the other, toward the relationship which it is proposed here to discuss.

That the artistic element is not recognized as it might or ought to be in the present American day is natural. The rapid development and growth of our land, the intensive study of science and the concentration of the efforts put forth to adapt it to everyday affairs, has exalted one phase of the economic idea, the quick attainment of profitable results, and clouded the truer, broader meaning that looks toward the best things and the highest life of the people. Into the midst of this active, restless, business life entered the engineer, doing more and more of its work and becoming more and more a recognized part of it and an undisputed element in its growth. He has acquired the characteristics of the life about him, zeal, energy, alertness, readiness in meeting quickly changing conditions, and absorption in the work in hand. He plans rapidly and executes to-day with an eye for to-morrow's profits. As another has said, "The world measures the efficiency of the engineer in dollars and cents," just in fact as it measures that of any other man, and engineers, as other men, largely accept the standard.

Time was when he was only the tool of some business man who had money to expend in a certain way and who employed him, under direction, because of some individual ability. But times are changing. In place of the isolated worker there is growing up a profession with professional standards and an esprit de corps, and

* Address of the vice-president before Section D, Mechanical Science and Engineering, at the Buffalo meeting of the American Association for the Advancement of Science.

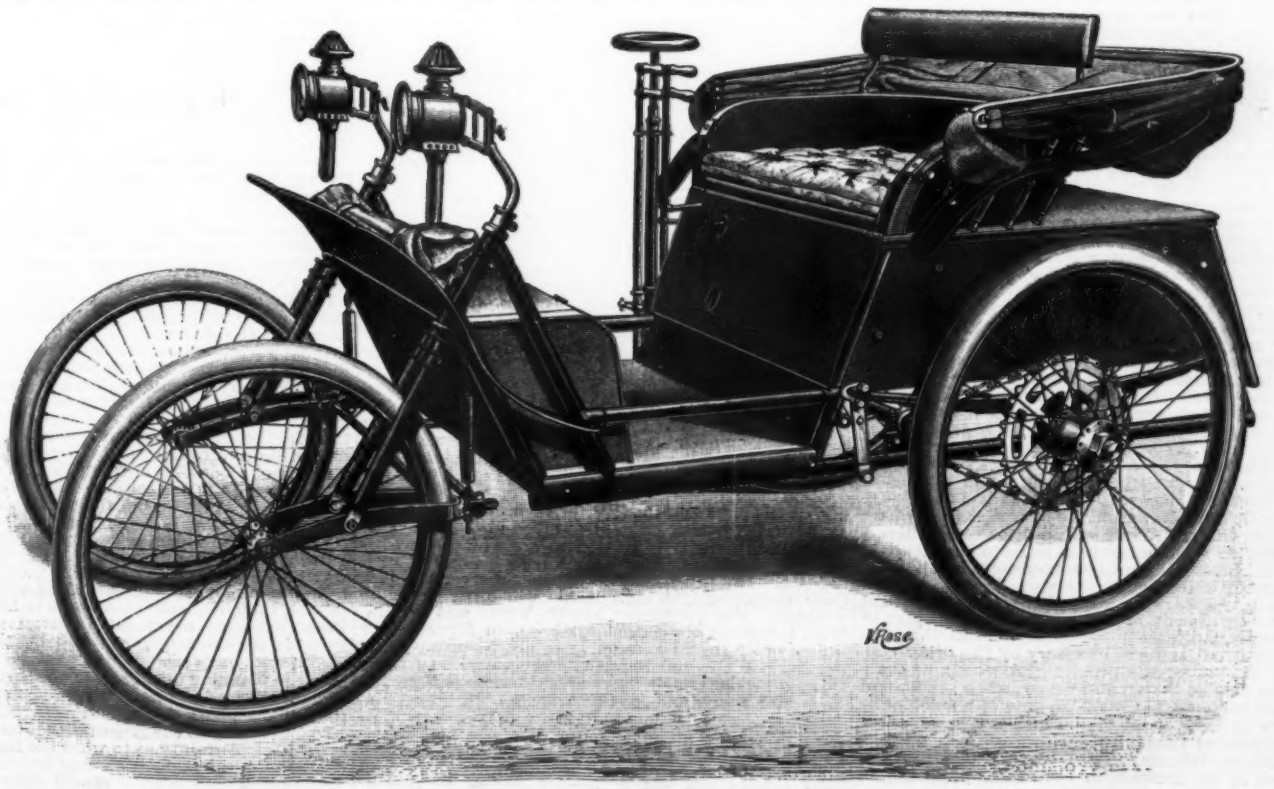


FIG. 1.—VALLEE'S GASOLINE CARRIAGE.

whose members are to be retained, not hired. Cultured, and with the openness and clearness of mind that only come from deep study, broad training and large experience, these are to be people of influence whose advice and services are sought, leaders whose judgments are respected and men who can mingle with the best anywhere on a common ground of attainment and character. They are to be intrusted with the expenditure of public funds in increasing extent and with an augmenting confidence. The very nature of an engineer's qualifications, his technical knowledge, the cultivation of his judicial and critical faculty, his training in fidelity to the trust reposed in him by private clients, all these fit him for places of large responsibility concerned with public works; and the people, tired of political management, are beginning to find this out.

These are no new thoughts, though none the less true, for others have recently written in confident strain of the coming engineer of the twentieth century. Yet it should be emphasized that the desired change is not, after all, so far ahead of us. To some extent, at least, the coming engineer has already arrived and is making himself felt. The leaven is at work.

With an engineering practice based solely on immediate results by way of expected profits in dollars and cents, the æsthetic element has little to do, though even here its absence may mean financial loss. But from the standpoint of this paper engineering is to be considered in the broader light of Telford's well known definition: "The art of directing the great sources of power in nature for the use and convenience of man," while the engineer is he who designs and executes engineering works.

It is not necessary here to dwell upon the breadth and comprehensiveness of these simple fundamental statements, but let us not forget that they are broad and comprehensive. With an engineering practice based on a generous interpretation of the above, the artistic has much to do.

The engineer is primarily a designer. He works with the materials of nature as his medium and her powers as his tools, wherewith to express his thought and his purpose to serve and benefit man. Just as in the making of a picture, the brushes, paint and canvas are not the chief things, so here it is not the stone, steel and brass or the powers of gravity, steam, air and electricity that are most important, but rather the character and quality of the design and the degree of realization in its execution. The design may be bad or good, according as it ignores or harmonizes with principles underlying all such acts of creation. The result may be a happy one only when the means employed are rightly chosen and properly adapted to the end sought. In this process of creating something of value, something that helps a man to a fuller, richer, and better life, the artistic cannot be left out. In its absence the design falls far short of its possible perfection and man is deprived of what is due him, though not perhaps distinctly conscious of the loss. In a certain sense, then, every engineer is an artist, and in some directions at least, as in architecture and other forms of construction and in the making of public parks, the result of his cultured brain may attain to the dignity of a work of "fine art." Perhaps, in its true essence, there may be as much fine art in the design of a machine to produce bolts as there is in the making of a picture for the Salon; certainly the well-planned tool with fine proportions and parts perfectly related is above the poor canvas.

To every true man there is a joy in creation that is not satisfied with anything less than the best of which he is capable. As Emerson has said, "I look on that man as happy who, when there is question of success, looks into his work for a reply, not into the market, not into opinion, not into patronage. . . . What is vulgar, and the essence of all vulgarity, but the avarice of reward? 'Tis the difference of artisan and artist, of talent and genius, of sinner and saint." But beyond this, which is the purely personal side of the matter, lies service, the designing for the use and convenience of man. From the vantage ground of his position as a man of educated intelligence and trained ability, the engineer owes the world his best effort. It needs and asks for technical skill and scientific knowledge whereby to-day's work may be done. But also, without knowing exactly what it wants, it feels the need of those added qualities it cannot define, and seeks for guidance and help to something better for to-morrow. In the long run, it will honor the man that meets the demand and will measure his efficiency on more grounds than that of dollars and cents.

To the superficial or hasty thinker there may appear a conflict here between the utilitarian and the artistic, but there can be no real antagonism. The result of an act of designing is to be judged as a whole in the light of all the purposes to be fulfilled. The physical conditions imposed by the materials used and the forces of nature employed are to be met. These conditions must be expressed in the design frankly and candidly, and in such a way as to indicate clearly its purpose and to gratify the observer through its proportion-, symmetry, harmony and decoration. The end desired must be attained in the most direct and simple way, so that the expenditure of money may be a minimum. These are the three elements of design, scientific, æsthetic and the financial. A disregard of the requirements of the first may mean structural or organic weakness, on the one hand; or on the other, an excess of material that unduly adds to the cost and at the same time may produce heaviness or ugly proportions in the completed work. Non-compliance with the demands of the second makes the design fail in fulfilling its complete mission; this applies with the same force to those cases where a poorly directed attempt has been made to be artistic in expression, as to those in which no attention whatever has been paid to the matter. Artistic treatment often costs money, yet the mere expenditure of cash will not secure it. On the other hand, the proper display of good taste may often come without the spending of a dollar more than is made necessary by the other conditions surrounding the problem. A wealth of ornamentation may be brazen and vulgar, while beauty and grace may be found in the simple lines of a machine or bridge, or in the curving of the curb by the roadside. The disregard of the financial side may mean either a weak, meager and unsatisfactory result, or an unwise lavishness in expenditure, in both cases producing in the long run a loss and waste of money.

The current engineering practice gives great attention to the first and last of these elements, and but little comparatively to the second. There is no branch of it but would be benefited by adding to scientific and business ability a knowledge of the principles of artistic design and an impulse to give expression to it. The effect on the life of our communities and the nation by such a change is not easily estimated. The writer does not expect, however, to see an immediate revolution. This is not a change that comes naturally in that way, but rather by way of development and growth, generally slow, although it may at times be accelerated. In this development our people as a whole must increase in artistic sensitiveness. We are not an æsthetic nation, but we have latent possibilities in that direction; we are young, confident and impressionable and have the courage to be original in design, which counts for much. We have evolved the American locomotive, the American truss bridge, the American automatic machine, the American much debated tall building, and many other things especially adapted to American needs. We shall grasp the artistic possibilities of construction quickly when we come to know what they are, and will apply them confidently, not always at first with the most happy results. We shall learn something from the old world and will assimilate much that is good in its practice, but in the end engineering here will be both artistic and American.

There are evidences here and there that this process of change is going on. American machine design when compared with that of other countries shows some marked characteristics. A writer in the Engineering Magazine says of these that "the best ones are directness of design, by which is meant the shortest cut to reach a given end, the designer having in mind the thing to be done quite as much as the machine which is to do it; lightness and a close proportioning of parts; in machine work a near approximation to pattern; rapidity of construction and rapidity of action in the finished machine; the substitution of special steels and new alloys, hollow construction, etc., for older materials and construction, and a generally neat appearance of work, and burrs, lips and roughness of casting removed. The American designer is not an artist like the Frenchman, but is more attentive to appearance than the Briton. He is gradually curing himself of the tendency to tawdry ornament, needless accessories of fancy castings, stenciled paints, japanning out of place and bright work for mere effect." These are good qualities and in the line of improvement. Some recent installations of power plants illustrate a movement that will have considerable influence on engine design. In many of our larger cities there are engine rooms fitted up in elegance, with marble floors and wainscot, decorated walls and ceilings, brilliantly lighted and with all the appliances of the plant, engines, dynamos, switch boards and even the smaller accessories in keeping with the surroundings. These plants are used as drawing cards or advertisements. There are other plants not so used, where there is displayed less elegance, but fully as much artistic sense in adapting the room and its treatment to its purpose. In many of these places only the inclosed type of engines can be used. In all of them the standard of maintenance must have its influence on the matter of design, which will in turn react on the former. An engine might pound itself to death in a dark basement, but would have its slightest vagary looked after in one of these better planned housings. This result cannot be entirely accounted for by the larger room, the better light, the rules and regulations. There is a refining, educating influence in these artistically planned constructions that makes better men and more efficient workmen of the attendants. Whatever they may cost, there is a credit side to the balance sheet.

Our railways are contributing toward this change. They have found the decoration of passenger trains a profitable thing, and so stimulated, have carried it to excess. Handsome terminal stations, adorned in good taste, are supplanting the dingy, forbidding and inconvenient places so long in use, while the shed type of depot is being crowded out by beautiful, quaint buildings set in the midst of lawns and flower beds. More significant still is the tendency to adopt a high standard of maintenance, under which the roadbed is kept trim and neat, flanked by sodded slopes and bordered by clean and well kept buildings, which also requires the rolling stock, the shops, and yards to be maintained in a high state of efficiency. This is not necessarily in itself artistic, but it furnishes at least a necessary foundation. That the railway management understands, to some degree, the commercial value of the artistic element in its business is further evidenced by the nature of its advertising, that seizes on any advantage of scenery or artificial effect that is at hand.

Not much can be said in praise of the artistic qualities of our bridges, for these attributes are conspicuous through their absence. The American bridge satisfies the conditions of stability and least cost, but of beauty of line or balanced proportion that make it fit into and harmonize with the landscape or even that makes it attractive considered by itself, it has little. And this is to be the more regretted because an intelligent application of right principles would much improve the effect, without adding much, if any, to the cost or making the structure less safe and durable. It is true that the truss with parallel chords, especially of the through type, does not lend itself readily to artistic treatment, yet even here something can be done. It is not so much a matter of adding ornament as the proper treatment of the organic lines, the length of spans, the relation of length of panel to height of truss, the location of the piers and the form of their outlines. Ornamentation is not to be used so much for its own sake, but rather where it is needed to accentuate these organic markings. There are some truss bridges of such size that they give pleasure to the observer through their massiveness, though lacking in other desirable qualities. The cantilever, like the Pratt and its relatives, is difficult of treatment, while arch forms, either braced or of the suspension type, are naturally pleasing and best adapted for artistic expression. Of these types we have a few satisfactory examples, like the Eads and the Grand Avenue bridges at St. Louis, the Brooklyn and Washington bridges at New York. In our public parks are to be found many small bridges of good design, while in our cities there are some creditable ones of larger dimensions. There is some tendency toward the use of curved chords in bridges designed for urban use, and a further evidence of interest in the curved line through the introduction of the Melan arch. In some respects it is unfortunate that the economical element has driven out the stone arch, which possesses so many of the elements of a beautiful structure for most situations, and it may be that this new form will become a substitute for the old, with added characteristics of its own. However much we may admire the inventive genius and mechanical ingenuity of those who have worked out the types of rolling or lift bridges that cross the Chicago River, the less said about the beauty of the designs the better. Perhaps the environment imposes ugliness on the designer. But that problem is hardly solved yet, and will not be, until some man gets hold of it that combines æsthetic with scientific qualities and has insight keen enough to see the possibilities of the situation and adroitness enough to manage, not only the physical, but also the human factors—a rare combination.

In the entire field of engineering there is no portion of it that includes a greater variety of intricate and difficult problems for solution than that connected with municipal life. Here the engineer has to do with matters touching the home life, the dwelling, its heating, ventilation and lighting, its drainage and water supply, etc. There is the business life that demands attention for the stores, office blocks, banks and exchanges, manufactories and shops, warehouses and elevators with all of their requirements of heating, cooling, lighting, ventilation, drainage, power and internal communication through elevators, pneumatic systems and alarms. Then there is the larger life of the city as a whole that needs public buildings, churches, schools, hospitals, libraries, museums, hotels, theaters, railway stations and markets, each with its own peculiar demands; streets and systems for rapid transit, both intramural and suburban; the distribution of water, heat, cold, light and power; pneumatic systems for carrying packages; electrical conduits; sewerage and garbage systems, with the plants for their treatment or disposal; wharves and railway yards; parks, boulevards, playgrounds, plazas; the opening of new territory to accommodate the city's growth.

The engineer here comes in close contact with the people that daily and hourly use the results of his work. He already influences their health and bank accounts for the better, gives them greater ease and convenience at work or play and saves their time. This is what is asked of him and he meets the demand well. But what an uplift would come to city life, how much richer it would be, if he could put an artistic quality into his designing and the people would learn to appreciate it. It is not to be inferred that there is an entire absence of this, but rather that artistic effects have been largely confined to individual cases, and not made manifest in the general life of the city. For instance, there are numerous examples of suburban dwellings, beautiful internally and externally and with harmonious settings; there are occasional business blocks whose treatment is satisfactory, but very few public buildings that have an adequate artistic meaning and are so situated as to express this advantageously if they did possess it. Without detracting in the least from the acknowledged merits of Trinity Church, Boston, it must be admitted that its roomy location on one side of an open plaza adds greatly to its effectiveness. Think of its being placed in the middle of a block on Washington Street, or set in the midst of brownstone fronts on Fifth avenue!

All public buildings need both room and an appropriate setting. They are the larger and more important pictures in the gallery of city structures; yet under the prevailing system of rectangular blocks, bounded by long, straight and narrow streets, the hanging committee has nothing but the walls of corridors on which to place them. The worst of the matter is that the exhibition is a permanent one. Along these alleyways must also be hung the narrow, vertically elongated panels that seem to be so popular to-day, in favor because they pay. The observer needs a twenty story ladder in order to study their details or even to know if they have any, and can find no point from which they can be seen as entireties. At their sides hang strings of pictures whose horizontality exaggerates their skyward tendency. It is not the modern tall building in itself that is here objected to, but its location on sites that will not admit of a display of its best qualities. With wide, clear surroundings and effective grouping they may be made agreeable, as is illustrated by the happy combination at the southeast corner of Central Park.

One of the good results of the tall building craze is the bringing closer together of two branches of designers; from the architect the engineer will learn more of art and he will teach the former better construction. While retaining their separate functions, the collaboration will result in a higher mutual respect and appreciation and a better grade of work on the part of each.

It is undisputed that the rectangular plans of American cities are neither adapted to meet æsthetic conditions nor the demands of traffic. The long streets, without variation in width and direction and without the breaks afforded by little parks, are tiresome to the eye. They are not placed with any regard to the topography or the natural features of the landscape or to give prominence to some important structure, nor do they furnish direct lines of travel. But the plan is weighted down to the ground by millions of money. So it is not a question of what it ought to be, but one of mitigating the present evils and avoiding a repetition of these in the future. Radical treatment must be resorted to by way of diagonal avenues from congested centers and the widening out of the intersections of important streets into parks and plazas. There must likewise be a heroic struggle with the water fronts and internal watercourses, places full of picturesque possibilities, though usually given over to filth and ugliness. These changes are made imperative not only by æsthetic requirements, but also by the demands of health and business.

In the planning of additions to large cities, the designer is hampered by the supposed necessity of tying to the older plans, by the desire of owners and speculators to realize to the largest extent on the sale of lots, or by his uncertainty as to what the future growth and character of the population may be. An examination of the block plan of many of our cities would show a heterogeneous arrangement of streets, especially in out-

lying districts, without regard to mutual relations, matters of grade and drainage or artistic position. This irregularity may be more inconvenient and less pleasing than a right angled plan. Our towns and smaller cities reproduce in miniature the conditions of the larger centers. Here again it is a question of improvement instead of original design, only the problems involved are not so intricate and their solution not so costly. So it is hardly possible for a designer to plan an ideal city or to have the full swing and liberty of the men who laid out the city of Washington and established its system of grades and drainage. But in spite of difficulties there exist some suburban districts, laid out, built up and adorned on the principles of good taste. Thanks to the systems of rapid transit that are increasing the number of these attractive places!

In the design and maintenance of water supply plants, American practice shows some respect for the artistic element. This is not confined to any particular system or any part of any one plant, but is quite general. The engine houses are not ugly and their interiors are often attractive. Gate houses, aqueducts and dams are decoratively treated and form pleasing features in the landscape. The slopes of reservoirs are kept trimmed and the grounds generally turned into lawns with flower beds and perhaps a fountain. No doubt, the sanitary conditions imposed have much to do with this, but the result is none the less in good taste. We cannot avoid, however, a stray shot at the ugly standpipe with conical cap, sometimes seen in our smaller towns. This is unnecessary. When inclosed it has been made an interesting object, and even the bare pipe can be ornamented in such a way as to relieve its nakedness.

There is much encouragement in the growing appreciation and enjoyment of public parks and boulevards. Cities and towns all over the land are trying to beautify what they already have and are adding new territory to their park resources. Admirable skill has been shown in utilizing the natural features of the local landscape, the rocks, tree masses, meadows, ravines, ponds and streams, the wide expanse of ocean or glimpses of bright water. The curving roads and paths, with undulating gradients, have a beauty of their own and lead one from point to point of the ever changing scene, and yet bind it all into one harmonious whole. While the landscape engineer deserves credit, not so much praise can be given park commissioners for the artificial adornments which they have added to his work. Notwithstanding the fact that these are sometimes labeled as artistic, they do not always fit in appropriately.

The writer firmly believes that there is a latent æsthetic quality in American life that is now struggling to find both means for its gratification and methods of expression. Before there can be knowledge of its meaning and power there must be many attempts and many failures. The whole process is one of education and that largely in the school of experience. This applies to the industrial and constructive arts as well as to the fine arts. The engineer will share in the general movement, but this is not enough. As a designer of so much that the world needs for daily use he must do more than keep up; he must keep in advance. He must not only have a capacity to enjoy, but also the power to originate and apply. To this end he must give preliminary study and thought to the principles of æsthetic design, so gaining an intellectual knowledge of them. American engineering schools are doing little or nothing to help the young engineer to this. So far as the writer knows, there is but one American text book, Prof. Johnson's book on bridges, that includes any discussion of the matter. A course of study in engineering æsthetics near the close of college life would be a great help and stimulus to a young graduate, at least opening his eyes to the fact that there was such a thing. After knowledge comes the application of principles as tests to an engineer's own work and to that of other men. And, finally, with theoretical and practical knowledge well in hand and a love of what is beautiful, comes the impulse to work artistically. With such engineers and an appreciative clientele American engineering would be artistic. To this end let us work.

FRANK O. MARVIN.

University of Kansas.

LOST ARTS AND RECIPES.

WHEN we reflect that the ancients possessed but very limited means for spreading knowledge of any kind, it seems somewhat strange that so much of it should have come down to modern times. But when it is taken into consideration, says the London Standard, that even since the introduction of printing, which is the greatest disseminator of knowledge that ever has existed, many secrets of recipes have been utterly lost, it is truly wonderful that the number of trade recipes which the ancients used, and which have been handed down to us, is not infinitely smaller than it is. But then those that are lost seem to be by far the most important—they are not merely of interest to the antiquarian and the different varieties of "ologists," but would be useful to those who earn their bread in the everyday walks of life. To know, for example, how the ancient Roman made his mortar would interest both the modern builder and his pocket. But, unfortunately for posterity, the modern builder can no more make mortar equal to that of the Romans than he can fly. If he could, there would be a chance that the buildings which he makes would last for some thousands of years—so long, in fact, as the stone lasts. This is the case with the mortar used by the Romans. It is as firm now as it was a couple of thousand years ago, so hard that a file will hardly touch it, and so lasting that the stones which it cemented together have begun to crumble away, leaving the mortar still intact.

Another secret which was known to the Romans, or at least to one of them, was one about glass. The story, if we recollect rightly, is told by Suetonius. An artisan brought to the Emperor Tiberius a goblet made of glass, a substance then recently discovered, which, when thrown on the ground, or squeezed in the hand, did not break, but was as elastic as steel. The only goblets in those times were made of metal. The only ones used in Roman society were made of silver or gold. Consequently the Emperor thought that, if the secret of making glass, goblets which were unbreakable became generally known, the trade of the gold and silver smiths of Rome would be ruined, and he therefore ordered the immediate execution of the artisan who invented the method of producing malleable glass. The order—as were most of the orders of an imperial despot—was promptly carried out, and the man's secret died with him, nor has it since been recovered.

The Greeks, so history tells us, were in the habit of using in their naval battles a substance which, when thrown on to the water, burned and set fire to the ships of the enemy. This substance went under the name of "Greek fire," but, unless it was the metal potassium, modern scientists do not know what it was—and even that element would not answer the purpose unless used in very large quantities. If, therefore, the famous Greek fire was potassium, the Greeks must have been acquainted with a cheap and easy method of obtaining it, and if they had that recipe, it is lost. To return to the Romans once more, Locusta, the head of the college of poisoning founded by Nero, knew of poisons which would kill to order, so to speak—that is, which would kill in a minute, a day, a year, or longer, and leave no trace. Apparently this recipe came down to the middle ages, for the Borgia family could do similar feats. Their victims would perhaps be presented with a pair of jeweled gloves, or a beautiful bouquet of flowers; but after putting on the first, or smelling the second, the victim would die within the day. Occasionally a visitor would be requested to open a cupboard—he did so, and was poisoned through contact with the handle, although there was no visible puncture. Cæsar Borgia again had a ring with a bezel shaped like a lion's head. If he shook hands with one of his victims while this ring was on his finger, a rapid death was invariably the result; but fortunately these toxicological secrets died with that infamous trio—Pope Alexander VI, Cæsar and Lucretia Borgia.

The English of early times did not know a great deal that we do not know now. But they certainly knew of a drug or of something which would protect the skin from heat. Editha, the daughter of Godwin, plunged her arm into a caldron of boiling oil and brought out the "holy stone" therefrom. She could not have done this without some such help. But although the secret of it is dead to us, it is most certainly known to some of the Eastern conjurers of to-day; for a feat similar to the above in every instance may be witnessed in almost every country of the Orient. The Italians, and the ancient Romans too, for that matter, had a method of mixing their colors so as to render them imperishable. A glance at some of the old Roman pictures in the British Museum will show that the colors of pictures painted nearly 2,000 years are almost as fresh, especially the reds, as they must originally have been. Raphael, Van Dyke, Rubens—in fact, all the old masters—possessed a similar secret. What their recipe was is not known, but certainly modern painters cannot mix their colors so as to make them stand the test of centuries. Fifty or sixty years at the most is what they will stand without showing a marked deterioration.

Another class of old masters—the violin makers—had a recipe which is lost forever. It was for a varnish which, besides preserving their instruments, sank into the wood and mellowed it. In spite of repeated efforts however, the modern violin manufacturers cannot make a similar varnish, and it is principally for this reason that their instruments, though very good, cannot rank even with a mediocre "Strad" or Amati. When Cortez conquered Mexico he found the Aztecs a civilized race. He found them masters of architecture and skilled in metallurgy. He found, too, that they were able to treat copper in such a manner that it could be hardened and tempered like steel. We have seen specimens of this copper cutlery—which is pure copper, almost chemically pure—which are equal in fineness of temper and hardness to the finest steel produced by our much vaunted scientific processes of to-day. Men have worked for a long time on this subject, for if copper of this kind could be produced now it would be invaluable for many purposes; but, so far, little or no success has attended their efforts, and the recipe remains a secret. The inlaying of sword blades with gold, at which the Indians were at one time expert, is another lost recipe, for even they cannot do it now, and only a few examples of gold-inlaid swords and daggers now remain to prove that at one time somebody possessed the secret for thus beautifying them without damaging their efficiency. In the middle of last century there lived in a Welsh village a blacksmith who possessed a recipe for welding steel without spoiling its temper. He was able to weld a sword blade in half an hour in such a manner that the joint was quite invisible, and the edge, temper, and brightness were as perfect as when the weapon first came from the factory. But he invariably worked alone, and would not even allow any one near his forge while he was at work; and, although he was offered large sums for the secret of his recipe, he never divulged it, and it died with him.

During the last two centuries even there have been recipes lost. For example, we cannot now make china as they used to make it. A piece of imitation Crown Derby could instantly be recognized as such, first, by the color, which cannot now be reproduced, and, secondly, by the glaze which the old potters used, and of which the recipe is entirely lost to us. The same applies to Lowestoft, Bow, and Chelsea ware—the glaze cannot be reproduced. For a long time it was not known how cameo Wedgwood was made, and when that was known the question arose, How was the Portland vase—now in the British Museum, and the only specimen of that kind of ware known—made? It was not made on the same principle as the Wedgwood ware, for although Josiah Wedgwood tried, he could not reproduce work anything like the original vase, the cameos on which stand out as sharply as the moon in a cloudless sky. Certainly the artist who produced the Portland vase had a recipe which is now lost, for not the slightest idea of how it was made exists, nor can even a reasonable theory be evolved.

HOT water is one of our best remedial agents. A hot bath on going to bed, even in the hot nights of summer, is a better relief for insomnia than many drugs. Inflamed parts will subside under the continual poulticing of real hot water. Very hot water, as we all know, is a very prompt checker of bleeding, and besides, if it is clean, and it should be, it aids in sterilizing wounds. A riotous stomach will nearly always receive gratefully a glass or more of hot water.

SELECTED FORMULÆ.

Summer Beverages.—

FLOWING STREAM.

Shaved ice	½ tumblerful.
One egg.	
Vanilla sirup	1 fluid ounce.
Orange sirup	1 "
Ice cream	1 tablespoonful.

Add a few dashes of bitters, rum, and orange extract. Fill the glass nearly full of cream, shake well, grate a little nutmeg on top, add a little soda water—using fine stream—and serve with spoon and straws.

GOLDENADE.

Shaved ice	½ tumblerful.
Powdered sugar	4 tablespoonfuls.
Juice of one lemon.	
Yelk of one egg.	

Shake well, add soda water from the large stream, turn from tumbler to shaker and back several times, and strain through a julep strainer into a 12 ounce tumbler.

MILK PUNCH SIRUP.

Brandy	4 volumes.
Jamaica rum	4 "
Condensed milk	1 "
Sirup	8 "

PEACH BLOW.

Peach juice	8 ounces.
Raspberry juice	2 "
Lemon juice	2 "
Comp. spirit juniper	4 "
Foam, quantity sufficient.	
Cochineal coloring	40 drops.
Sirup	3 quarts.

EGG CREAM.

Cream	4 ounces.
Four egg yelks.	
Extract vanilla	1 "
Sirup	12 "

—Merck's Market Report.

Toothache Drops.—The following is a carefully selected collection of formulas for toothache drops from the American Medico-Surgical Bulletin:

1. Oil cajeput (rectified) } parts of each 1
   Oil cloves } parts of each 1
   Chloroform 2
2. Camphor ℥ ij
   Chloral hydrate ℥ ij
   Triturate till liquefied; then add
   Spirit peppermint to make fl. ℥ iv
3. Oil cloves } equal parts.
   Tincture cannabis indica } equal parts.
   Chloroform } equal parts.
4. Oil peppermint } equal parts.
   Spirit ether } equal parts.
   Tincture opium } equal parts.
5. Menthol ℥ ij
   Ether fl. ℥ iv
   Oil cloves fl. ℥ ij
   Fluid extract aconite fl. ℥ j
6. Fluid extract Jamaica dogwood Oj
   Oil peppermint ♏xx
   Ether fl. ℥ j
7. Creosote 2 parts.
   Chloroform 2 "
   Wine opium 4 "
   Tincture benzoin 1 "
8. Oil eucalyptus fl. ℥ j
   Mastic ℥ ij
   Camphor ℥ iss
   Morphine (alkaloid) ℥ iss
   Chloroform fl. ℥ ij
   Alcohol to make fl. ℥ v
9. Camphor 1 part.
   Chloroform 9 "
10. Oil cajeput (rectified) } equal parts.
    Tincture opium } equal parts.

Blotter Substitute.—A cheap and excellent substitute for blotting paper may be extemporized as follows: Mix fourteen parts (by weight) of plaster of Paris and two of potato flour with sufficient water to produce a plastic paste. Pour or press into a suitable mould, and as soon as the mass becomes hard and dry it affords an admirable blotter.—The Paper Trade.

Glazing Gelatine Prints.—Many amateurs are troubled by having their prints adhere very firmly to the glasses to which they have been squeegeed for glossing. In some cases this is caused by putting them on the side of the glass which was not prepared for them. To remedy this, paint a large B with Brunswick black on the back of the glass. This will insure the same side always being used. Pieces of paper put on for this purpose are often washed off. To clean the glasses thoroughly, take a few drops of solution made by dissolving thirty grains spermaceti wax in five ounces of benzine, and rub it all over the glass with a piece of paper until the surface is polished. Repeat this every time the glass is used.—Photographic News.

Clearing Solution.—To remove yellow stains caused by developer:

Iron sulphate	3 oz. or 90 grms.
Sulphuric acid	1 oz. or 30 c. c.
Alum	1 oz. or 30 grs.
Water	20 oz. or 600 c. c.

First wash well to remove all hypo from the negative, then immerse in the above solution until the stain is removed; again wash well and dry.—American Journal Photography.

Mites and Chicken Lice Exterminator.—J. B. S., Mound City, Kan. A dusting powder may be made as follows:

Lac sulphur	1 ounce.
Insect powder	2 "
Naphtalin (moth camphor)	2 drachms.

Rub them together to a fine powder and dust on chickens with an insect powder gun or from a pepper box, also sprinkle the powder around the house or coop.—The Formulary.

ENGINEERING NOTES.

The necessary works for the establishment of a coaling station for the German navy at the eastern mouth of the Baltic Canal are to be begun soon. The coal stores, which will be 174 meters long and twenty-one broad, are to be on the south side, close to the harbor for torpedo boats. They are intended both for coals and briquettes, and will have seven loading stages, and be encompassed by a railway with several lines of rails, three of which will run along the stone pier separating the torpedo boat harbor from Kiel Bay. The water by the pier is so deep that a fleet of warships could coal there. The station, the plans of which have now been sanctioned by the authorities, is to be finished in two years, and will be able to store about 77,000 tons.

The effect of the reduction of fares on French railroads in 1892 has been studied by W. Heussler, an officer of the Swiss Central Railroad. The reduction was made by the railroad companies on condition of a reduction of a heavy government tax on tickets, which made part of the price paid by the passenger for his journey. Mr. Heussler compares the results for the year 1893 with those for 1891, the change having taken place in the course of 1892. The public has certainly profited by the change, for while the distance traveled increased from 4,766,000,000 passenger miles in 1891 to 5,737,000,000 in 1893, the amount paid for fares and tax together fell from about $81,500,000 to $78,500,000; that is, the public got 20½ per cent. more traveling for 3¾ per cent. less money.

The British consul at Jerusalem writes that since the opening of the railway between Jaffa and Jerusalem the necessity for a harbor at Jaffa has become all the more urgent, and sooner or later it will have to be constructed, or the Jaffa-Jerusalem railway will have to be extended to Port Said. As far as tourists are concerned, the advantages of a connection by rail with Port Said would be very great, for the intervening country being perfectly level, the distance—about 220 or 230 miles—could be accomplished in ten hours. Jerusalem could thus be visited without the necessity of a sea voyage to Jaffa, where in rough weather the landing is uncertain; and travelers on their way to or from India and Australia would also have an opportunity of seeing the Holy Land by breaking their journey for a few days at Port Said.

The first platform of the great tower at Wembley Park has been opened to the public. The base of the tower covers about an acre of ground, and the platform, which has just been completed by Messrs. Heenan & Froude, the contractors, is at an elevation of 155 feet from the ground, or 400 feet above the sea level. The whole tower when completed will be 1,150 feet in height. From the first platform, on a clear day, the Crystal Palace, Windsor Castle, and the grand stand on Epsom Downs can be distinguished. Access is gained by means of two lifts constructed to carry fifty-five persons each, and worked by means of steam engines underneath the base of the tower. The platform is composed of concrete on metal girders; 2,000 tons of steel have already been used in the construction of the first platform.

A most important argument urged on behalf of high pressure is, that by its adoption a smaller caliber gun may be made to produce the same effect as the present 12 inch gun of 46 tons. A table is given showing that a 10 inch gun of about 24 tons, and about 23 feet 6 inches long over all, working with a maximum pressure of 30 tons per square inch, will give 25,911 foot tons of energy, and will penetrate 25¼ inches of wrought iron, or within a fraction of the 25·74 credited to the present 12 inch service guns of the Majestic. The advantages claimed on behalf of this ten inch gun are very considerable, being no less than the following: The gun would be much handier in action, and less vulnerable, owing to its less length. It would be loaded and fired more rapidly, since the weight of projectile and charge would be only 634 pounds, as against 998 pounds in the case of the 12 inch gun. It would cost less than the 12 inch gun, in the proportion of 24 to 46. The gun with 100 rounds of ammunition would weigh 52 tons, against 91 tons in the case of the 12 inch gun. Yet the guns would be of equal power.—United Service Gazette.

In a discussion on a recent paper by Mr. R. Davison, on "White Metals for Wearing Surfaces," before the Institute of Marine Engineers, Mr. James Adamson said he remembered one steamer at Glasgow which required to have the whole of her main bearings filled up with new white metal within nine months. She had only made two round voyages before the whole shaft had to be lifted and the main bearings refilled with white metal. After the ship was lined up, she ran with the second lot of white metal for nine years, and, he believed, it was actually cheaper in price. He was acquainted with another steamer which ran for fourteen years with the same metal that she had in when she left the builder's hands, and she was running hard during all that time. Another steamer ran for eight years without her bearings requiring to be lined up, and still another ten years. He had found from experience that a hydrocarbon oil ran better with white metal bearings than ordinary engine oil, and in the case of the steamer to which he referred that ran for twelve years without her bearings having to be lined up, nothing but hydrocarbon oil was used from the time she left the builders' hands. Mr. Adamson gave an instance where white metal had been applied to worn eccentric straps with good results. These straps, he said, had previously given trouble every voyage, and in one case the brass had worn down ⅛ of an inch in a six weeks' voyage. White metal was then put into them, and they had now been running for nearly four years without giving any trouble whatever. There were six of these eccentric straps, and they were treated with three different kinds of white metal as an experiment. All of them had done equally well and had never given any trouble. He did not think that white metal did well, as a rule, with water, especially salt water. Mr. Wilson said he found white metal in a certain ship, and they could only run it with the best castor oil and a little water. The moment they took the water off they had trouble. That only referred to the bottom ends. The main bearings ran a little better. —The Engineer.

ELECTRICAL NOTES.

Globular lightning set fire to a woman's dress near Angers, in France, during a recent storm, the burns causing her death soon after.

The Canadian General Electric Company are building a 400 horse power electric locomotive. The hauling capacity is expected to be about 15 loaded freight cars at a rate of 30 miles per hour. It is proposed to use the locomotive between Hull and Aylmer.

The Acetylene Illuminating Company of Queen Victoria Street, London, have, it is stated, concluded arrangements with the British Aluminum Company, who are already located at the Falls of Foyers, by which they will be able to erect works of several thousand horse power, for the manufacture of calcium carbide, using water power. Pending the construction of the proposed works, they have obtained the use of a considerable portion of the spare water power of the existing works of the British Aluminum Company, at Foyers, and a carbide plant is now being erected there, which it is expected will be in full work during the month of October.

The Ohio legislature legalized execution by electricity and the law came into force July 1. The authorities advertised for bids for the electrical equipment, but that the manufacturers have no desire to sell their apparatus for this purpose is evidenced by the fact that none would bid, as in New York State; it is probable that the machinery will have to be purchased by strategy. It is very satisfactory that the constituted authorities should have this trouble, for execution by electricity is a clumsy and expensive way of taking life when the cheap and effective gasocution is always possible. It is no recommendation for any maker's electrical apparatus that it is used to take life.

Journalists in St. Petersburg have been busy chronicling what they describe as a series of remarkable telephonic experiments which have been recently made in Moscow, in the course of which messages, airs, and songs were conveyed by means of M. Keldushoffsky's new telephone between Moscow and Rostoff on the Don. The distance between these two towns is 1,340 versts, or 900 English miles, while the wire used on this occasion was over 1,800 miles long. It is stated by the representative of the Moscow Gazette, who witnessed the experiments, that the inventor of this new telephone soon intends visiting England, in order to see whether telephonic messages cannot be conveyed from England to America by means of the transatlantic cable.

It is stated that some of the lamp manufacturers in Germany are now using chemical processes in conjunction with the air pump for exhausting incandescent lamps. A piece of amorphous red phosphorus is placed within the tube connecting the lamp with the exhaust pump. The tube is gently heated while the pump is acting and when carried sufficiently far the current is gradually raised to about three times the normal voltage and then reversed frequently. When blue light fills the globe the tube is sealed off, so that the lamp tube still contains the phosphorus. The operation is then repeated until the blue light disappears, leaving a light brown deposit on the glass. An experienced workman is said to perform the entire operation in about two minutes.—Philadelphia Record.

An electric heater has been devised for use in oil wells, says the Electrical Age, which it is hoped will make used-up wells as good as new. The common theory as to exhaustion of so many wells is that the oil, in passing upward through the stone, has clogged the porous stone with paraffine in such quantities that the further flow is stopped and the well ceases to produce. Some think that it is because the supply in the earth has given out, but the generally accepted idea is that the oil is still in abundance, and only ceases to flow when the exit is stopped. The stone through which the oil passes is of a very porous nature, and as the liquid is in a crude state, the thick matter becomes as dregs, settling in the rock near the edges of the bottom of the well. It has been common to use torpedoes to shatter the stone at the bottom of the well, thus breaking up the clogged matter; but this is an expensive process. The electric heater melts out the paraffine and restores the original conditions.

Il Nuovo Cimento for July contains some very interesting contributions. A. Garbasso writes about the discharge of a cathode by flame gases. The products of combustion of a candle give rise to exactly the same phenomena in the spark gap as those produced by Roentgen rays and by ultra violet light. They promote the discharge when impinging upon the cathode, but produce no effect upon the anode. If a glass plate is brought between the knobs so that the discharge can only just pass around the edge, a candle placed below the cathode on one side of the plate produces a shower of sparks, while when placed under the anode it stops the discharge altogether, if anything. This action is not due to the heat of the flame. The gases can be led up to the knob through a tube 40 cm. long, and the tube can be immersed in cold water, without altering the effect. Besides, a current of hot air does not produce the effect described, whereas it may be brought about by the smoke from a cigarette. Signor Garbasso suspects that the discharge produced by ultra violet and X rays may be a secondary effect, and may be due, as in the case of a flame, to the action of electrified particles in the shape of dissociated molecules. Dr. Maiorana gives the results of his studies of the effect of light upon the resistance of selenium. He finds that the effect is anything but "instantaneous." The resistance of a piece of selenium, with a normal resistance of 258,100 ohms, was lowered in the first second of illumination to 224,000, in the second to 212,000, and after that it gradually approached a limit of about 200,000 ohms. The recovery proceeded equally gradually. We also find a description of the new system of electrical distribution patented by Profs. Ferraris and Arno. The system is to provide for the case when the same current has to be used for lighting and power to nearly the same extent. The ordinary alternate current is sent through the lamps, and the power portion is transformed so as to suit the requirements of polyphase motors. This is done by the "phase difference transformers" designed by the inventors.—London Electrician.

MISCELLANEOUS NOTES.

In the kitchen attached to the dining car of the fast express from Ostende to Vienna there are a number of cases sealed with the custom seals of Belgium, Germany, Bavaria, Austria. They contain wines of the respective countries, the dining car company being allowed to use free from duty only the wines of the country the train happens to be traversing.

Sometimes even the best of rubber tubing becomes brittle and has a tendency to break. It does not necessarily betoken an inferior article. The conditions causing the change have not been thoroughly examined, but the best and most elastic tubing will be found to gradually part with its elasticity, a change due, it has been said, to the formation of sulphuric acid by the action of moist air on the sulphur of the compound. It can be avoided by occasionally placing the tubes in a slightly alkaline solution and leaving them overnight.

A new method to manufacture illuminating gas from coal dust consists in allowing the coal to enter in a continuous stream a retort heated at the outside and by means of a feeding arrangement in the top of the retort. The material, scattering into a cloud of fine dust, passes the hot part of the retort, where it is instantaneously destructively distilled, leaving the solid residue, coke, behind. The latter is matted together by the heat to a coherent mass, and falls to the bottom of the retort, while the gases are carried away by a pipe for further operations.

A new method of manufacturing glass vessels which will not break under sudden changes of temperature is announced from Germany, the plan adopted being to make the article with an inner layer having a lower coefficient expansion than the outer layer. Articles made in this way seem to have the useful qualities of Bastie's "hard glass," without the tendency to spontaneous explosion; and the making of them is in most cases easy, as the operator first takes up on his blowpipe a mass of the glass with the lower coefficient of expansion, and the more expansive glass is now taken up on the outside of the first by dipping in another pot.

A German woman, a drunkard and thief, born in 1740, has had 834 known descendants up to date, according to Prof. Pellman, of Bonn, who has been able to trace the career of 709 of them. Of these, 106 were born out of wedlock, 208 were professional beggars, 181 prostitutes; 76, including 7 murderers, got into jail; in seventy-five years these persons have cost the state more than 5,000,000 marks. Prof. Pellman has gathered these statistics to prove the injurious effects of alcohol, but a writer in the Lancet points out that they seem to show that it does not diminish fecundity, and that the proportion of children reaching maturity is far above the average.

An explanation of the practice of ringing two bells to start a street car is given by the Phiiadelphia Record, and, if not trustworthy, it is ingenious. It is said that when horse cars were first used, one bell was used to start the car and one bell to stop it. The horses soon broke down. They foundered at the knees or their shoulders gave way. Every device that could be thought of was tried to ease up the strain of starting. Spiral springs were put on all the traces, but no good resulted. Finally a countryman, who had been employed a week as a driver, suggested that two bells be used to start the car, and he averred that when the horses got used to it they would set themselves at the first ring and be ready to pull at the second. The plan was tried, and was so successful that it has been in use ever since.

The New York Sun says: "In no more emphatic manner are modern facilities of transportation emphasized than in the safety with which perishable food is conveyed from a great distance. In this particular Australia, South America and the United States are no further removed from Europe than a single province formerly was from the capital of the country of which it formed a part. Algeria is now supplying Paris markets with camel meat. An extensive plant has been created in that French colony for the killing and refrigerating of those animals, and daily shipments are made to Paris. The meat of the camel is described as not unlike beef, with the tenderness of veal. The hump is the choicest portion. Eggs that formerly were gathered near the localities where they were sold now come from distant points. Four million daily are received in London from foreign countries. Most of them come from Russia. They command in England twice the price they bring in the home market. The export of eggs from Russia, that in 1885 amounted to 235,000,000, increased in 1895 to 1,250,000,000. These are official figures. The larger proportion of this product goes to England. In addition, great quantities of dressed fowl are annually exported from Russia to all European countries."

By a combination of the Bertillon method of measurement with the fingerprint system any prisoner can be identified with almost absolute certainty and in a very short space of time. Mr. Galton calculates, says the Westminster Gazette, that the chance of two fingerprints being identical is less than 1 in 64,000,000,000, and when we consider the relatively small numbers of the criminal population, and that other personal evidence would be available in any doubtful case, mistaken identity ought now to be a thing of the past. The method of indexing fingerprints proposed by Mr. Galton is at first sight somewhat complicated, but with a little practice we are told that about five minutes will suffice for the complete verification of any one of 2,632 sets forming a directory. A specimen directory of 300 sets has been given, together with numerous fingerprints. The method of obtaining the prints is to press the thumb or finger upon a plate of copper which has previously been coated with a very thin film of printer's ink. The inked fingers are then pressed or rolled upon the card which is kept as a record. Although fingerprints have been used as a sign manual from the earliest times, yet it is only recently that they have been studied from a scientific point of view, and the evidence accumulated is as yet insufficient to enable us to realize their value to the anthropologist. Now that a good system of classification has been worked out, it is to be hoped that observers will multiply rapidly and that the bulk of the material at our disposal will soon be considerable.

[Continued from SUPPLEMENT, No 1082, page 17295.]

APPARATUS FOR THE MANUFACTURE OF ACETYLENE GAS.

II.

"AT HOME" Apparatus of the Acetylene Gas Company (Fig. 14).—This apparatus is based upon the equilibrium of pressure that is established between two communicating vessels. It consists of a gas generator and a gasometer.

The generator enters a galvanized iron tank filled with water. It consists of a galvanized iron cylinder weighted with lead, P. It is formed of two parts, A and B, connected by three joint screws fastened by thumb nuts. The water enters the lower part, A,

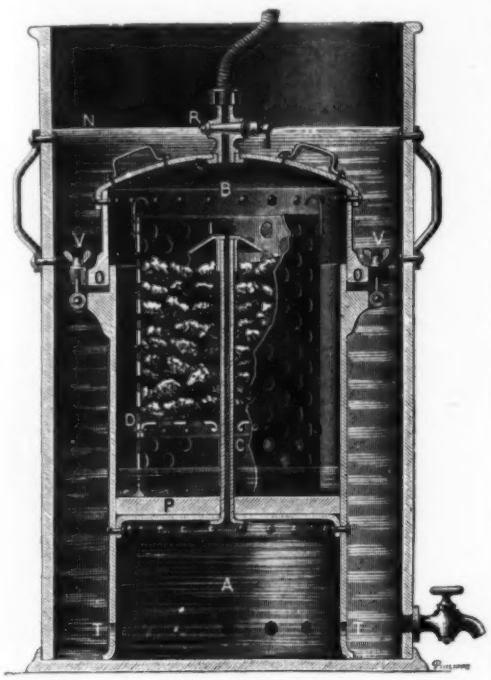


FIG. 14.—"AT HOME" APPARATUS OF THE ACETYLENE GAS COMPANY.

through apertures, T, and rises into the tube, C I. When it reaches the upper orifice it flows over the cap, I, and falls into the metallic basket, D, containing the carbide. The gas produced through the attack of this substance fills the upper part, B, and through the junction pipe fixed to the cock, R, flows to the holder of the gasometer, which rises when the pressure reaches 8 inches of water.

The difference of level between the water of the tank and the orifice of the cap is less than 8 inches. As soon as the pressure balances this difference of level, the flow of the water is arrested. When it reaches 8 inches it forces the water into the tube, C I, up to 2 inches beneath the orifice, I. During the entire time that the holder is raised the water preserves this level

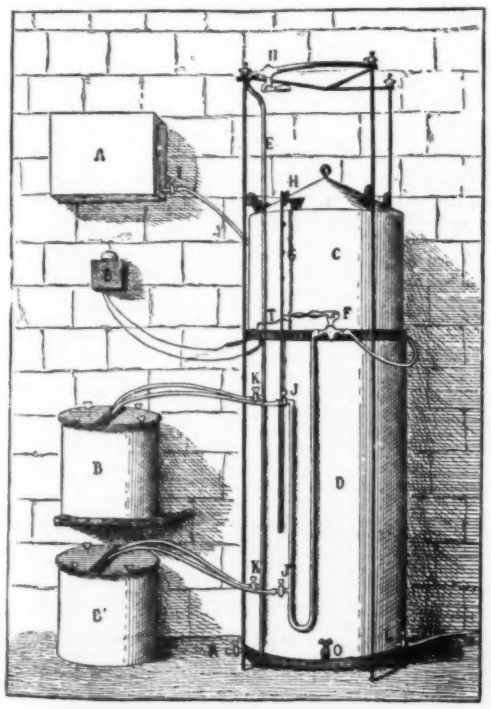


FIG. 15.—LEROY & JANSON APPARATUS.

in the tube, and, consequently, cannot fall upon the carbide.

As the gas contained in the holder is consumed at the burners the holder descends. When it rests upon the bottom of the tank, the gas gradually loses its pressure. The pressure decreases also in the generator, and the water then ascends in the tube and flows anew over the carbide, with the consequent production of another supply of acetylene.

When the burners are extinguished, the apparatus ceases to operate. As a certain quantity of gas continues to be produced in consequence of the humidity contained in the apparatus and accumulates in the gas holder, it is necessary to take care to extinguish the burners only at the moment at which the holder is upon the point of reaching the bottom of the tank, and not at the moment at which it begins to ascend after an attack of the carbide.

The Leroy & Janson Apparatus (Fig. 15).—This apparatus consists of a reservoir, A, of two generators, B B', and of a gasometer, C D. The reservoir, A, contains the water necessary for the attack of the carbide (which is contained in but one of the generators) and must be filled when the latter is exhausted. Each of the generators consists of a receptacle containing a vessel filled with the quantity of carbide to be decomposed. It is closed by a cover with a rubber washer held by means of bolts with thumb nuts.

The gasometer tank, D, is provided at its upper part with a lever cock, F, which is closed through the action of a spring. This cock communicates on one side with the cock, I, of the reservoir, A, and on the other with a tube ending at the cocks, J and J', that feed the generators. It is the most important part of the apparatus. It opens when its lever encounters one of the four tappets, G, of a rod, H G, guided by a slide and dependent upon the motions of the holder, C; and such opening takes place only when the holder descends or is at the bottom of the tank. The water is then introduced through one of the cocks, J, the second, J', having to be opened only after the first has been closed, that is to say, after the exhaustion of the first generator. The acetylene produced flows through the central tube of the generator, the cock, K, and the tube, E K K', to a condensation box provided with a purge cock, R, that serves for extracting the products of combustion from time to time, and finally enters the gas holder, from which it makes its exit through the cock, L, in order to supply the burners used for lighting.

The tube, E K K', terminates above in a safety cock, N, identical with the cock, F, and that opens under the action of the tappet, H, of the rod, H G, when the holder is at the very top of its travel. This should occur only accidentally. For example, should the cock, F, leak, thus giving rise to too great a production of gas, in such a case, the safety cock, N, would open and allow of an escape of the excess of gas into a tube that would lead it to the exterior. This cock, N, serves further for the expulsion of the mixture of air and acetylene contained in the holder at the time at which the apparatus is set in operation.

Finally, like several of the apparatus already described, this one is provided with an electric alarm, S, whose circuit is closed by the contact, T, and the upper part of the rod, H, when the holder is nearly at the end of its downward travel. Warning is thus given that the generator in service is exhausted and that it is necessary to set it in operation again.

The Serpollet-Letang Apparatus (Fig. 16).—This apparatus is a gas generator-gasometer whose operation is analogous to that of the hydrogen briquet. The one represented in the figure is designed for discharging 58 cubic feet of acetylene (corresponding to 11 pounds of carbide) without being recharged. It consists of an external cylindrical reservoir having a bottom in the form of a truncated cone closed by a screw plug and closed at the top by a cover that fits very closely but is not absolutely tight. A tripod supports the reservoir and holds it far enough from the floor to allow of the placing under the bottom orifice of a bucket to receive the residue of the decomposition when the recharging of the apparatus is begun.

A holder capable of ascending and descending freely in the external reservoir contains a basket of carbide which is held in place by uprights and spring clasps. The gas produced is led to the exterior by a system of two vertical tubes connected with each other by a reservoir serving as a cleanser, and which forms a U with unequal branches. The longer of these branches is connected with the tubing by means of a joint that is easily removable and of perfect tightness.

When the flow of the gas takes place, the level of the water rises under the holder and reaches that of the carbide. The acetylene is then disengaged and drives back the water, which ceases to be in contact with the carbide. There is thus established between these actions an equilibrium that varies only with the intensity of the discharge. The mobility of the holder, moreover, corrects such irregularities as might be produced through abrupt changes of pressure.

The lime formed passes through the meshes of the basket. The carbide is therefore always directly in contact with the grate. When the consumption of the gas is suppressed, as its pressure in the holder causes the level of the water to lower a few inches beneath the carbide, the production of a new quantity of acetylene must cease, apart from that due to the humidity of the gas and of the wires of the basket.

The Beau & Bertrand-Taillet Apparatus (Fig. 17).—This apparatus consists of a gas generator and holder in which the acetylene is produced by a series of successive falls of carbide of calcium into a volume of water.

It consists of two tanks, one placed within the other, and of a holder which moves in the annular space between them.

Under the cover of the holder are suspended movable tubes, A, closed by plugs and each containing about 4½ pounds of carbide. These are four or seven in number, according to the size of the apparatus. The extremity of each tube is closed by a valve, B, which, through the play of a counterpoise, P, opens in order to allow of the passage of the carbide.

The cover is, in addition, provided with a safety valve, J, and a mouth, E, serving for the introduction of a few pieces of carbide that are thrown into the tank to start the apparatus.

The water necessary for the manufacture of the gas is then led from a reservoir, C, through a cock, H. The mixture of air and acetylene is let out through a cock placed under the drier, F. The apparatus is thus ready to operate.

After the holder has descended to a sufficient distance, the counterpoise that closes the valve, B, of the tube, A, is arrested. This valve opens, a first charge falls into the water and the holder ascends again. The gas produced passes through the drier and purifier, F, and flows to the burners through the pipe, G.

In measure as the gas is consumed, the holder descends anew until it opens a second valve, which allows a new supply of carbide to fall. The gas is thus produced through successive droppings of the carbide into the water until the last tube is exhausted.

As shown in the figure, all the counterpoises are at

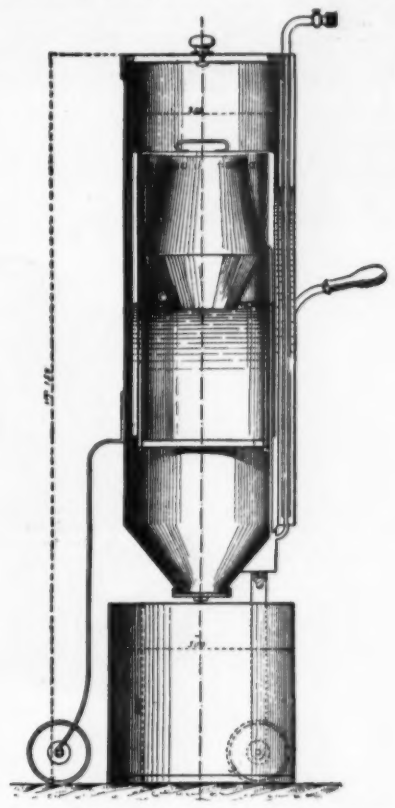


FIG. 16.—LETANG-SERPOLLET APPARATUS.

different levels, so that they can be arrested only one after the other when the holder descends. Finally the last tube contains a supply of carbide a little larger than that of the first, because the holder has a longer travel to make after the operation of this latter tube.

The lime water produced is removed by means of a siphon provided with a cock, D. The apparatus may be charged and cleaned while running. Finally, since the carbide falls into an excess of water, the heat due to the reaction does not exceed 35° or 38°.

The petroleum industry of Russia has just lost its pioneer by the death in Sweden of Robert Nobel. It

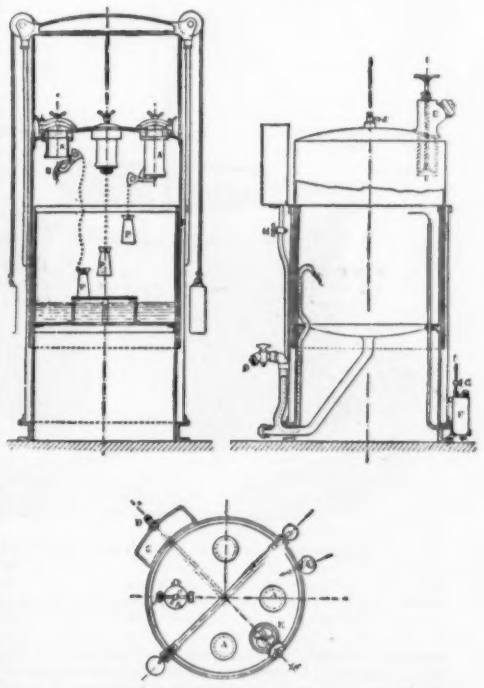


FIG. 17.—BEAU & BERTRAND-TAILLET APPARATUS.

A, tube containing the charge of carbide; B, automatic valve; C, water reservoir; D, clearance cock; E, aperture for the introduction of carbide for setting the apparatus in operation; F, drier; G, gas port; H, cock for the introduction of water; J, safety valve.

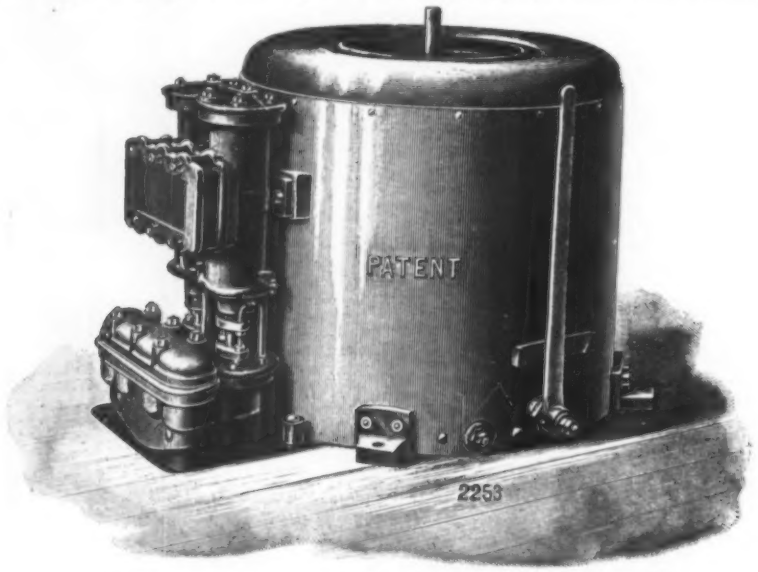
was to a chance visit to Baku, in 1873, that he owed his great discovery of the rich deposits of petroleum in the Caucasus. Taking his brothers into partnership, he founded, with the help of the Muscovite government, a business which is at the present moment the only serious competitor of the American Standard Oil Company.

THE LAUNDRY, SANITARY AND GENERAL ENGINEERING EXHIBITION.

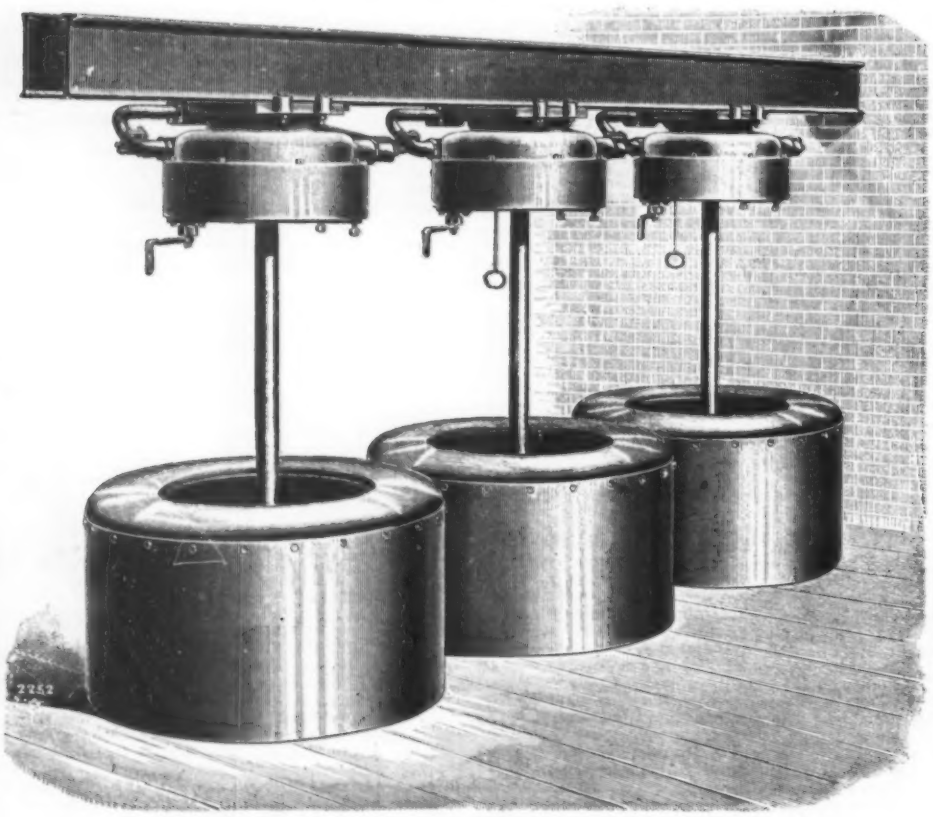
The fourth Laundry, Sanitary and Engineering Exhibition was opened at the Agricultural Hall, London, on Monday, August 24, and closed on Saturday, September 5.

The power used in the exhibition exceeded 500 horse power, some 230 horse power being communicated by belt and the remainder by supplying steam at 75 pounds pressure to the numerous direct-acting engines attached to the various machines shown in operation.

We show in the accompanying engravings, for which, with the article, we are indebted to Industries and Iron, the exhibit of Messrs. Watson, Laidlaw & Company of hydro-extractors and centrifugal machines by hydraulic pressure. This system is applicable to both the over and under driven types of machines, a high pressure jet water motor being directly connected to the spindle, the motor being driven by water under suitable pressure supplied by a pump. Although, as in one of the machines shown, a steam pump can be connected to each hydro, the advantage of the hydraulic system is more apparent where a number of machines are in use in one works. In the latter case, a pump of suitable size may be placed at any point to supply water under pressure to a number of hydro-extractors in any part of the building, only a pressure and exhaust pipe being required. It will be apparent from this that the machine becomes much more accessible all round, there being no engines or belting in the way, and consequently more hydros can be laid down in a given space than under the old system of driving. We are informed that the cost of running the extractors direct by hydraulic power is not more than by steam, and that where a natural supply of water under pressure is available no pump is required, thus reducing the cost. We imagine that it is not often that such natural supply will be available, but Messrs. Watson, Laidlaw & Company informed us that they have already carried out a contract where such favorable conditions existed. When a pump is employed there is no waste of water, as after performing its work it runs into a supply tank, from which it is pumped back again to the motor. In the case of a single water-driven hydro, this tank is situated below the basket, being in fact an extension of the casing, but where several machines are driven by one pump, the water is returned to a common tank. The water motor is stopped and started by the movement of a single lever fitted to the casing of the machine. It is under perfect control, arrangements being provided whereby the basket cannot exceed a predetermined safe speed. Three water-driven hydros are exhibited, the largest being a 48 inch suspended machine. Apart from the method of driving, the extractor is of the firm's well-known design, except that at the exhibition, instead of being supported from an iron standard, it is shown bolted to and suspended from a heavy wooden beam. This type is sold principally in Russia, where the import duty on the heavy iron standards and casings is such that wooden beams made in the country are used in preference. The second machine is a 30 inch under-type hydro, the water motor in this case being entirely hidden by the casing. The pressure water for these two machines is supplied from a Worthington horizontal duplex steam fire pump, an example of driving two hydros from one pump being thus shown. The third machine is similar in size to the last one described, but in this case the pump—a vertical duplex one—is bolted to the casing of the machine, suitably covered in. Another point about these water-driven machines is that water is used in place of oil for lubricating the spindle bearing, and consequently the goods treated in these machines are thoroughly protected from all chance of damage by the dropping of oil from the bearings or motors.



GENERAL VIEW OF UNDER-DRIVEN TYPE WITH PUMP ATTACHED.



GENERAL VIEW OF A BATTERY OF OVERHEAD DRIVEN MACHINES ACTUATED BY ONE PUMP AT A DISTANCE.

WATER-DRIVEN HYDRO-EXTRACTORS.

Apart from the foregoing, Messrs. Watson, Laidlaw & Company show several of their well known suspended and under-driven centrifugal machines, driven either direct by a steam engine or by belting. The first machine on the stand is a 48 inch suspended extractor, driven by a steam engine fitted to the frame of the machine. The engine does not drive direct, but by means of a belt, thus allowing the engine to run at a moderate speed and therefore to effect a considerable saving of steam. An improved form of pivot extractor is shown, suitable to be driven by belting or by a small steam engine. The machine exhibited has a basket 24 inches in diameter, the improvements which have been effected being in the direction of making the hydro more compact than before. A machine of similar size, but of the suspended type, is also on view. At the side of these two hydros is a small vertical steam engine, with cylinder 4 inches in diameter by 6 inch stroke, which may be coupled direct to the 24 inch hydro when direct driving is desired. The engine is self-contained, and having a circular sole plate, and made very compact, can be set down in almost any position. The engine is fitted with Macfarlane's safety governor, which gives a very regular speed and entire security from running away. Three sizes—12 inch, 18 inch and 24 inch—of the hand power geared extractors, introduced last year, are to be seen on the stand. These machines have recently been improved in various details, with the view of making them more suitable for the purpose for which they are intended, viz., for use in small laundries. Pressure of space prevents us from dealing at length with the other exhibits at this stand, which comprise a small oil extractor, used for extracting the oil from iron turnings; steel disk pulleys, both for belts and ropes; and a self-oiling swing bearing, which is used exclusively in machines of the firm's manufacture.

THIN CAST POLISHED GLASS.

A NEW DEPARTURE IN PLATE GLASS MANUFACTURE.

Never, since the manufacture of blown mirrors, for centuries monopolized and secretly guarded by Venice, which from Murano supplied the royal courts and ducal villas with those splendid works of Italian genius which are still the admiration of our age, was confronted by the superior cast and polished plates with which Lucas de Nehou and Abraham Thevart astonished France and the civilized world from the Faubourg St. Antoine, which afterward was merged into the magnificent plate glass works at St. Gobain, has there been introduced into the manufacture of cast and polished plate glass such an epoch marking, radical and fundamentally revolutionizing labor-saving and cost-reducing machinery as that which is the subject of the recent patents of the Marsh polishing and grinding machinery; and hence, a brief description of a process which is certain to enlarge American industry and cheapen the product, will prove interesting to manufacturers, importers, dealers and consumers.

The revolution of industry by steam-moved machinery, historically considered, has been very slow, and for one hundred and fifty years foreign plate glass plants were located with a view to their proximity to forests and waterways, in consideration of fuel supply, grinding sand and water power. Natural gas at Kokomo, Elwood and Alexandria, Ind., an unlimited supply of silica at Crystal City, Mo., and the Westmoreland coal fields of Pennsylvania are mainly responsible for the location of the only American plate glass plants which have thus far been located outside of valleys coursed by large inland streams, the beds of which furnish the vast amount of grinding sand annually required in this industry.

England and France have, by means of their superior machinery and by jealously guarding the secrets and technique of the industry, made the civilized world pay tribute to them for nearly two hundred years. But from 1860 to the present time, the introduction of improved machinery has made the plate glass industry international, and Germany, Austria-Hungary, Belgium and the United States have swung into line, and are to-day formidable rivals in an industry in which for more than a century they led the way, and our modern colossal plate glass plants, which have increased the domestic production from 1,700,227 square feet in 1880 to the present productive capacity of 18,500,000 square feet per annum, warrant the assumption that the United States will and must in a very brief period supply entirely all plate glass consumed within our borders, and is destined to become a powerful rival, as an exporting country, in the markets of the world.

To do this, however, plate glass must be made cheaper than is possible to produce by the primitive or antiquated methods now pursued, and the immense amount of small sizes and all of the thin polished plate which annually reaches our shores from foreign factories now making a specialty of this class of goods, and which are made in American factories incidentally and accidentally, must be made specially by other processes than those now in use.

No polished cylinder glass has ever been manufactured in this country, and very little domestic window glass has ever been found of such uniform high quality as to fit it for silvering. The American importer has been forced to supply domestic consumers of polished cylinder from Germany, Austria-Hungary, Belgium and the Netherlands. The value of silvered and unsilvered blown cylinder glass annually imported amounts to about $2,000,000 exclusive of the duty. During the last two fiscal years, which have been marked by low imports, there were imported in 1895, 3,461,836 square feet, valued at $847,990; for the fiscal year which closed June 30, 1896, imports reached 3,579,105 square feet, valued at $1,339,025.

Most important of all are the imports of thin blown cylinder, polished, silvered and unsilvered looking glass plates, not a foot of which has ever been made in the United States, despite the fact that these goods are almost exclusively used in the manufacture of furniture, whereof we annually produce $125,000,000, and export annually over $3,000,000 worth, not to mention the vast amount of this class of glass annually used in the construction of railway, electric and traction cars, in which we fully supply the enormous domestic demand and export fully $1,500,000 worth.

In a special report on the American glass industry, Diamant, Leipzig, No. III, under date of January 21, 1894, says, in regard to this line of glass manufacture:

"The manufacture of this polished plate glass in

America is not specially followed. The very extensive factories of Pilkington and St. Gobain have monopolized the manufacture of this class of glass, for which there is a large demand in the construction of railway and traction cars."

The introduction of the Marsh process for polishing in the manufacture of thin cast and blown glass will make it possible not only to break down this foreign monopoly, but will enable American manufacturers to build up a large and profitable industry for which there is an immense future already assured.

For more than two hundred years plate glass had to be embedded in plaster, and this expensive operation, requiring time, care, and skilled labor and an enormous amount of plaster, had to be performed twice at the grinding table and twice upon the polishing tables, as each plate has to be turned twice and be embedded four times. Upon the polishing tables especially the underlying bed of wet plaster retards the polishing process, as glass cannot be polished until its temperature is raised considerably, and this necessary heat, imparted under the old process by the frictional action of the polishers, has always been slow and costly. The consequent expansion of the sheet, and its liability to break the adhesiveness of its incasing bed, thereby necessitating relaying and the probable assumption of a different plane, all add to the cost, uncertainty and precariousness of plate glass manufacture.

Again, the method of releasing the ground or polished plates from their adhering plaster bed, by prying and wedging up the under side, has always resulted in an enormous amount of breakage, incident to and inseparable from the methods pursued, and this loss or waste is always increased, in proportion as the glass is light or thin, and lacks the strength to resist the necessary prying and wedging to loosen it.

E. A. Hitchcock, formerly president of the Crystal City Plate Glass Company, in his testimony before the Ways and Means Committee, stated that the loss from breakage in the grinding department alone was 10 per cent. and that in all departments the loss was fully 50 per cent. of the entire output. Direct reports from the books of some of the best equipped and best managed works in this country prove that the above is not an exaggerated statement. Fully 35 per cent. of all the breakage results from prying the glass from the plaster bed, and from unequal expansion resulting from the cold contact of the plaster under and around the edges of the sheets, and the superheating of the top and center of the embedded glass.

Through all this breakage, waste of time and labor, cost of plaster, its preparation, application and removal, the Marsh process cuts a most radical swath. The rough plates are cast, not thick, in order to give them resisting strength, but thin, in order to save the expense and labor of grinding them down, for there is no more prying and wedging to do. The grinding and polishing tables are made of two steel plates, horizontal, with water and air tight joints at the edges, and around the circumferences of the water pockets and pneumatic suction apertures, which interline and alternate side by side between the top and bottom plate of the tables.

The upper surface of the top plate is provided with indented squares, 4 × 4 inches apart, the dividing outlines of which are planed true, the interspaces retaining the percolating and circulating warm water, which is constantly supplied automatically to the indented squares. Over these squares and their alternating suction apertures sheets of paper pulp are placed, upon this the sheet of glass to be ground or polished is laid, and is there held as fixed and firmly as a Pullman car wheel under the applied power of the Westinghouse air brake. By the simple turning of the air valve, the sheets are fastened or released instantaneously, without gouging, prying, wedging or breakage of any kind, and all is done with such expedition, cleanliness and minimum expenditure of labor as is impossible to achieve or even approximately imitate with the process hitherto pursued.

The paper pulp takes the place of plaster at a much lower first cost, and is rerolled for subsequent and continuous use. Its porosity allows the circulating water to permeate its entire surface, thus heating up the glass instantly and uniformly, and thus saves the time and expense of accomplishing the same result by the friction of the polishing felt. The expansion is therefore uniform, and breakage of the glass or loosening the encasement, as is the case with a plaster bed, is entirely obviated.

As a result of these features, which are radical and fundamental departures from the beaten paths pursued hitherto, the time of polishing has been reduced to two and a half hours, while the English and Belgian polishing machines now in use require from six to eight hours to accomplish the same results.

We personally witnessed the grinding and polishing of cast plates one-eighth of an inch thick and the grinding and polishing of a double thick blown sheet, the latter of which, in the final operation of polishing, was reduced to 1-16 of an inch in thickness, an achievement which has always been thought to be impossible, and which is impossible with a plaster-embedded glass. —China, Glass and Lamps.

THE RIVOIRE MUSIC REGISTERING APPARATUS.

THE Rivoire registering apparatus is a mechanical stenographer of musical thought. It gives the composer a means of instantaneously fixing an improvisation, and makes it possible for a professor to show his pupil, piece in hands, what errors in execution he has committed.

The apparatus, the whole of which is inclosed in a wooden box, is placed under the keyboard. Under each key it suffices to form an aperture in the bed of the piano for the passage of a rod that transmits the musical thought to a pen through a mechanism that we shall describe. Such preparation, which upon the whole is quite simple, permits of applying the apparatus to all pianos.

Suppose the composer is at the piano; a simple ungearing starts the apparatus and causes the rod to rise and abut against the key. If the rod is lowered, the piano returns to its normal state, and the apparatus is at rest.

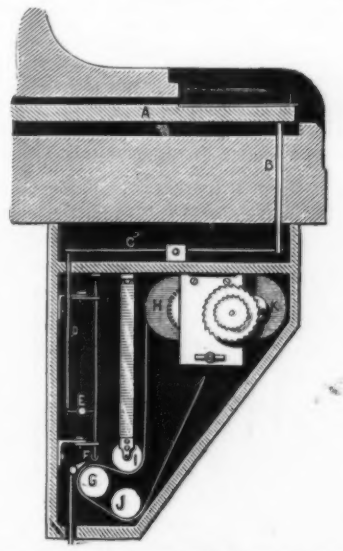
If the composer places his finger upon a key, the pressure that he exerts immediately actuates the rod, R. If the form of the piano had permitted it, the inventor might have placed the essential part of his apparatus at the extremity of this rod; but such not being the case, he had to have recourse to a lever, C, which gives another steel rod, D, parallel with the first, an up and down motion. To the extremity of D there is adapted a transmitting rod, E, that gives an up and down motion to a rod, F, which is provided at its extremity with a wheel, M, that is always kept inked by an appropriate arrangement. To recapitulate: a pressure upon the key gives an up and down motion to the wheel, M, through a series of rods and levers. On another hand, a clockwork movement unwinds, at the uniform speed of 50 inches a minute, a band of paper wound upon the roller, K. This band passes over the cylinders, G, I, J, the object of which is to put it in contact with the pen, F, when the latter is actuated. Then, after it has received the signs that are thus automatically inscribed upon it, the band winds around the receiving cylinder, H, whence it will be only necessary to unwind it in order to read or criticise the finished improvisation.

How is such reading done? In measure as it unwinds, the band is regulated mechanically by a series of dashes in the direction of the motion.

The interrupted dash of the center represents the do that separates the key of sol from the key of fa. The other dotted lines, la and do in the key of sol, and mi and do in the key of fa, are, in a manner, register marks.

In reality, the reading of this new method of musical inscription is done in about the same way as that of the music that we ordinarily decipher, each note occupying in the two writings an identical place upon the stave; only flats and sharps are determined by the position that they occupy and not by the aid of a particular annotation, and they always find a place in the interlines. This granted, let us set the apparatus in operation. Every note that the beginner touches will be inscribed upon the band of paper in the form of a dash whose length will determine the duration. Nothing is easier, moreover, than the reading of the inscription thus obtained, thanks to a small movable cardboard keyboard, which is proportioned to the width of the band of paper, and which it suffices to slide over it in order to have each key cover each note stenographed upon the band. But the use of this device will soon become useless to whoever has familiarized himself with the operation of the apparatus. In fact, he will soon learn to read the open band and will disdain the use of a measure bar, which is maneuvered with the left foot and which permits of the decomposition of the musical inscription into measure and time.

We have said that the band unwinds at the speed of 50 inches a minute. As it is 246 feet in length, it will therefore last an hour. On another hand, the clockwork movement that actuates the mechanism needs to be wound up only every twenty or thirty minutes.—L'Illustration.



SECTION OF THE MUSIC REGISTERING APPARATUS.

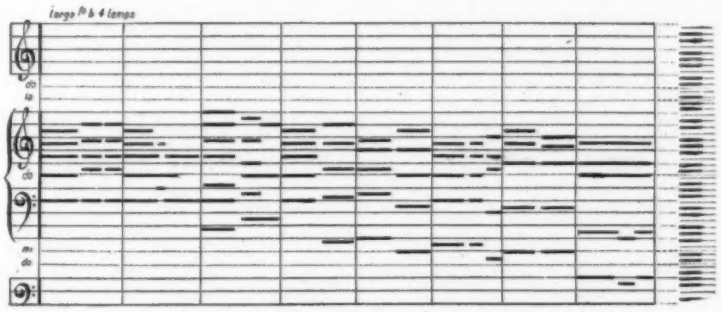
MAPLE SUGAR.

CHILDREN in all parts of the United States know what maple sugar is. Their young hearts have too often been delighted with this toothsome product of the maple tree sap for them to forget about it during the summer and fall, although there is then practically none in the market.

The men and women of beautiful rural Vermont, who supply almost all the maple sugar used in the United States, collect the sap from their trees in April, and in a week or more the freshly made brown cakes and the golden maple sirup are in the city stores in all parts of the country.

Of course there are sugar maple trees in other States than Vermont. Considerable sugar is made in New Hampshire and Northern New York, and a few Massachusetts people find enough trees on their property to pay them for the trouble of collecting the sap. But in every part of Vermont the sugar maple is found, and a few men own orchards containing more than 5,000 trees, while orchards of 2,000 and 1,000 trees are very plentiful.

FIRST MEASURE OF THE RUSSIAN NATIONAL HYMN.



NOTATION OF THE ABOVE MUSIC UPON THE REGISTERING APPARATUS.

The sap of the sugar maple begins to run about the 10th of March usually, and continues three or four weeks, according to the weather. Sap will run only when the thermometer registers at least 32° F., and stops flowing as soon as the frost is out of the ground, or directly after the snow is gone. Sometimes the cold weather comes late in the spring it is nearly the 1st of April before the thermometer goes above 50°. In 1895 the farmers around Brattleboro, Rutland, Bellows Falls, and other places did not tap their trees until the last day of March.

During the last of March and the first of April there is little else going on in the rural parts of Vermont except the making of maple sugar and maple sirup, and there is never a time when Vermonters accumulate wealth so rapidly or entertain their city relatives so sumptuously as at the sugar season. The only trouble is that this spring harvest is, at best, of only short duration, and as soon as the buds commence to start, the maple will allow none of its sap to pass off through the "spiles," and the sugar maker might as well close the business for the season.

There are few people outside of Vermont and other New England States who have more than a vague idea of how maple sugar is made, notwithstanding the many attempts to explain it satisfactorily in geographies. One must either see the process or very correct photographs of it to get a good idea of how those little cakes of maple sugar we see in the fruit and candy stores are made.

Even the government officials in Washington are nearly forty years behind the times. On a sugar making license dated January 6, 1804, which I saw the other day, there was engraved in one corner a scene among the sugar cane of Louisiana, and in the other corner was represented the sturdy Vermont farmers gathering the sap from their sugar maples into buckets carried on the ends of a yoke swung across their shoulders. There are probably not 100 yokes in constant use in the whole State of Vermont to-day. The method is still decidedly primitive. A pair of oxen or horses hitched to a sled containing a large tank or tub, which will hold several barrels of sap, is the correct thing now in use, and which has been in use for many years.

But outsiders can hardly be blamed for not knowing of the changes, for the men who make our maple sugar do not advertise themselves very largely. They live in the midst of some of the finest scenery in the United States, work hard and have comfortable, happy homes, and when they can dispose of their good maple sugar for 16 cents per pound they do not care whether outsiders think they collect the sap by carrying pails from tree to tree over their shoulders or by a circuit railway.

The Sunny South can scarcely boast of a people more willing to entertain visitors than Vermonters. No one fails to have a delightful time in rural Vermont when there is "sugaring off" at the farm. And the sojourner in Boston during the middle or last of March who fails to take a "run" to the beautiful country of Northern Massachusetts and Central and Southern Vermont knows not what New England life is, nor does he realize what really pure maple sugar is.

Northern New England life, with the making of maple sugar left out, would be like Mississippi without its cotton or Delaware without its peach orchards.

Then, too, the pure product of the sugar maple is hard to find in the city markets, as jobbers adulterate both sugar and sirup with glucose and cane sugar until the compound cannot be recognized by a Vermonter, whose State has enacted laws providing severe penalties for any adulteration of her maple products.

The sugar season comes at a time when the Vermont

farmer cannot profitably employ his time otherwise, and, taken all in all, the sugar industry is one of the most remunerative sources of income of the Green Mountain State.

The term "sugar orchard" is generally the one used in speaking of the maple tree portion of a Vermont farm; "sugar bush" or "sugar lot" are terms frequently used, however. If some Southerner, accustomed to his great truck farms and fields of sugar cane, were to speak to a Vermonter about the latter's "maple sugar farm," the Vermonter would probably laugh. More than one Vermonter has doubtless smiled at Thackeray's account of American maple sugar making which he gives in one of his books, "The Virginians," I think. He makes one of his characters describe a visit to the Vermont forests in the fall of the year, when the leaves were beginning to turn and the "Indians were beginning to gather sap from the sugar maples." I am afraid that Thackeray's friend didn't see much of the sap at that time of the year.

A Vermont sugar orchard is not like a peach orchard or an apple orchard. The maple trees are not set out in rows and carefully pruned. The trees that make up a sugar orchard on a Vermont farm have mostly "growed," like Topsy. They are there because it is their native soil and climate, and they form a part of the woods on the farm just the same as any other trees. Of course a farmer can enlarge his sugar orchard by planting. Sometimes there will be a great many maple trees together in the woods, just as some woods have almost no other trees, save pines or oaks. Then there are sugar maples along the roadside, and some in the fields. They are all part of the "sugar orchard."

Botanically, the sugar or rock maple is known as Acer saccharinum, and there are several ways in which it may be distinguished from the white maple (Acer dasycarpum), which it most resembles, and the red maple (Acer rubrum). One method is by the opening of the flowers, which always precede the leaves in the last two named, but the flowers appear with the leaves in the sugar maple. Another method is by the shape of the leaf. The leaf of the sugar maple is usually five lobed, with the two lower lobes much smaller than the others, and each lobe is slightly three lobed.

The sinuses between the large lobes are rounded, and this is the distinguishing feature of the leaf, for in the other two maples the sinuses are sharp, often as if made by two intersecting arcs of circles.

As soon as the weather is favorable, the Vermont farmer gets out his buckets and gets to work tapping his trees as quickly as possible.

The maple trees are tapped by boring the trunks with a small bit—usually half inch bit—about one and one-half inches deep, and from one to three feet above the ground. Trees are not tapped until they are about one foot in diameter. After tapping, a spout made of clean maple, beech, tin or galvanized iron, and fitted with a hanger for holding the bucket, is driven firmly into the hole made by the bit. A bucket of tin or wood is hung upon the spout, and the tapping process is finished. The buckets are like ordinary water pails, generally all alike, and each farmer usually paints all his buckets one color.

Only one hole is bored in young trees, but it is not uncommon to have as many as six buckets, with two spouts each, hung to maples of large size. If the bucket fills with the sap in a day, the run is a good one, although twice this amount is obtained in exceptionally favorable sap days. What is called a "good sized" sugar orchard will contain from 500 to 800 trees, and in the northern and central parts of Vermont orchards of 2,000 to 4,000 trees are not uncommon.

When the sap begins to run well, the farmer and his family must work hard. A man with a large farm must employ help outside of his family frequently, and use two or three pairs of oxen or horses to make the rounds of the trees with a sled, on which is the large sap tub, into which the sap from the buckets is poured. An orchard of 700 or 800, or even 1,000 trees, need not require the farmer to hire help if he has two or three boys in the family besides himself. From an orchard of 700 trees an ordinary run of sap for two days will enable the farmer to collect about eighty barrels. Sometimes sixty barrels of sap can be collected from 700 trees in one day.

As soon as the men begin to collect the sap the fires in the big evaporator furnace must be started, and the boiling of the sap begun as fast as it is brought in, so that none will be wasted by souring, or that the quantity brought from the woods may not so far exceed the accommodations at the house that while waiting to get room for it much will be wasted at the trees. At the time when the sap is running freely the farmer must often keep the fires going and the sap boiling all through the night, and, of course, he is likely to have to work all day Sunday and Sunday night. It is all-important that he "make hay while the sun shines."

When the work is hardest, the fun is at its best. Those who have but a small orchard will spare some of the family to help a relative or neighbor through sugaring.

And the sugar parties—what one of Vermont's sons or daughters ever forgets them?

At the party the hot sugar is dropped upon the snow and forms into "frogs" and various other imaginative reproductions of animal life before it is considered at the stage of perfection for eating. Some have bowls of snow and saucers of hot sap, and the great fun of a "sugaring off" party is to sit on the woodpile covered with buffalo skins and "candy" the sugar by pouring a spoonful on the snow in the bows, and then eat it with doughnuts and crullers. Sometimes a small branch of striped maple or beech is dipped into the kettle, and you have the fun of twirling it until it cools. Then you can break off the candied branches.

The modern evaporator makes it possible to do much sugar making in a short time. The evaporator is made of tin, copper or galvanized iron, and is so constructed that the sap flows in at one end, and by means of partitions extending nearly across the pan is made to take a zigzag course to the other end, where it is drawn off as sirup. The sap in the pan is kept shallow—about one-half inch in depth—and evaporates very rapidly. Rapidity of evaporation is greatly to be desired, not only on the score of economy of time, but because the sooner the sap is converted into sirup after it runs from the trees the lighter will be the color and the finer the flavor of the sirup and the sugar.

The sugar house is a rough little building with a shed full of well dried cord wood. The room is mainly occupied by the boiling apparatus, and with the bunk of the man who has to watch pans of boiling sap day and night. One side is taken up by the oven, which is built on a bed of brick, and consists of two brick walls, about two feet apart, two and one-half feet high and about twelve feet long. A huge old-fashioned brick chimney is at one end, where there is also a sort of square brick furnace to hold a big kettle. In the roof, near the center of the ridge pole, a large slot opens to the sky as an escape for the steam, which rises in heavy volumes from the pans on the fire.

The sap as it comes from the maple tree is like water and has barely any more flavor than good water. But it doesn't take much heat to produce flavor. A barrel of good sap will make a gallon of sirup or eight pounds of sugar. After being reduced to sirup in the evaporator the product is allowed to cool and settle, more or less impurities being precipitated by standing. The sirup is now ready for putting into cans for sale. The size most in use is a one gallon can.

The proper consistency of sirup is generally conceded to be 11 pounds to the gallon and this degree of density is reached at 219° F. The sap is never made into more than sirup in the evaporator. Then it is poured into a large porcelain lined kettle to be boiled to sugar. If wanted for sugar, the boiling is continued until the thermometer indicates 232°, for pail sugar, or 238° or 240° for cakes, when the mass is removed from the fire, stirred briskly for a short time, and then poured into tin pails or cake moulds, as the case may be, to harden.

The cake moulds are often a series of parallel partitions on a large wooden board, with space in them about three inches apart, and just wide enough to admit a knife blade. The moulds are dampened with a sponge, then the hot water poured in. Little fancy tins are also used for moulds. The farmer gets anywhere from 10 cents to 18 cents a pound for his sugar, and from 75 cents to $1 a gallon for his sirup. A sugar maple produces on an average about 3½ pounds of sugar during the season. The foregoing particulars were furnished to the Globe-Democrat by their special correspondent at Brattleboro, Vt.

THE NATURALIST'S CAMERA.

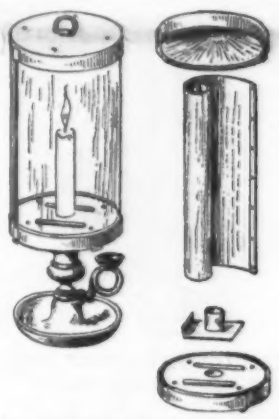
THE apparatus represented in the accompanying engraving is designed for taking photographs of birds,

NATURALISTS' CAMERA.

to general, of animals that cannot be approached. It enters into the category of tele-objectives. It draws out to a length of about 13 inches from the lens to the screen. It magnifies four and a half diameters. Back of the lens there is a mirror that has an inclination of 45° and that sends the image to a second mirror, which sends it to an astronomical telescope. The operator, therefore, sees the objects in the place that they occupy upon the sensitized plate. As soon as the focusing has been effected, the internal mirror is turned down. A curtain shutter is uncovered, and, at the end of exposures varying from ½ to $\frac{1}{25}$ of a second, there are obtained images of distant objects eight times larger than those obtained with the ordinary apparatus. These advantages recommend the camera (which is called the "Naturalist") for applications less pacific than natural history.—Le Monde Illustré.

PORTABLE PHOTOGRAPHIC LANTERN.

FOR some time past, what are called "vitro-metallic panes" have been making their way in the industries. These consist of strips of galvanized metal glazed with



PORTABLE PHOTOGRAPHIC LANTERN.

an insoluble material, and are flexible, unbreakable, light and sufficiently transparent and more diaphanous than ground glass. They are much employed in stables, workshops, etc., where glass in similar situations would be infallibly broken. For some time past they have been used as coverings for hothouses, in order to protect plants from the heat of the sun or from frost. They become heated very slowly and also radiate but slowly the heat that they have absorbed.

A new application is the use of them in the manufacture of portable lanterns for amateur photographers. The materials for this lamp consist of two metallic disks forming the top and bottom of the lantern and of a simple vitro-metallic plate that may be rolled up like a sheet of ordinary paper and be placed in one's valise. At the moment desired, the plate is unrolled and fitted to the disks forming the top and bottom of the lantern. Finally, the lantern thus formed is provided with an ordinary candle. This done, the amateur may proceed to develop his negatives in a room of any hotel that he puts up at during his excursions.—Le Monde Illustré.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid. to subscribers in any part of the United States or Canada. Six dollars a year. sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ASTRONOMY.—The National Observatory at Paris and the Astro-Physical Observatory at Meudon.—The famous old observatory of Paris and the recently erected observatory at Meudon.—2 illustrations..... 17307

II. AUTOCARS.—The Vallee Gasoline Carriage.—A recently exhibited motor carriage with tubular frame and gasoline explosion motor.—Description of a special tire by the same inventor.—3 illustrations..... 17311

III. ELECTRICAL ENGINEERING.—An Electric Dredger.—A floating dredger built in Rotterdam from Spanish designs for use on the Rsia River, Spain, designed to be worked from shore by electric transmission of energy.—1 illustration..... 17310

IV. ENGINEERING.—The Artistic Element in Engineering.—A vice-presidential address before the section of Mechanical Appliance and Engineering of the American Association.—A very suggestive and practical paper..... 17311

V. MECHANICAL ENGINEERING.—The London Sanitary and General Engineering Exhibition.—New forms of hydro-extractors are shown.—2 illustrations..... 17316

VI. MINERALOGY.—Precious Stones.—By Prof. HENRY A. MIERS.—Lecture II.—Conclusion of this most interesting paper describing lecture experiments with minerals to demonstrate their properties.—2 illustrations..... 17308

The Largest Diamond.—Popular account of the largest diamond ever found.—A specimen available for mechanical purposes only.—1 illustration..... 17309

VII. MISCELLANEOUS.—Lost Arts and Recipes.—A description of recipes that have been supposed to have been lost to human knowledge.—A fascinating subject popularly treated..... 17313

The Tamers and Trainers of Wild Animals.—A graphic account of trained animals and incidents of the trade therein.—3 illustrations..... 17314

Selected Formulæ..... 17333

Engineering Notes..... 17334

Electrical Notes..... 17334

Miscellaneous Notes..... 17334

VIII. MUSICAL INSTRUMENTS.—The Rivoire Music Registering Apparatus.—A mechanical stenograph of musical thought.—2 illustrations..... 17307

IX. NAVAL ENGINEERING.—Electric Turret for Armorclads.—The application of electricity for working a ship's turret as carried out by the famous French gun builder Canet.—2 illustrations 17310

X. ORNITHOLOGY.—The Migration of Birds.—By CHARLES DIXON.—An interesting description of this phenomenon of bird life.—Descriptions of observations made at lighthouses..... 17306

XI. PHOTOGRAPHY.—A Naturalist's Camera.—1 illustration..... 17311

Portable Photographic Lantern.—1 illustration..... 17315

XII. TECHNOLOGY.—Apparatus for the Manufacture of Acetylene Gas.—A continuation of a valuable article describing some of the leading forms of generators.—4 illustrations..... 17315

XIII. TRAVEL AND EXPLORATION.—Li Hung Chang's Trip Around the World.—Some of the incidents of the Chinese statesman's journey.—Anecdotes about the introduction of railroads into China.—13 illustrations..... 17313

BUILDING EDITION

OF THE

SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

MUNN & CO., 361 Broadway, New York.

CATALOGUES.

A Catalogue of Valuable Papers contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address; also, a comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *nearly fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Labels, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them; directions concerning Labels, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 622 and 624 F Street, Pacific Building, near 7th Street, Washington, D. C.

PAGE
17307
17311
17310
17311
17310
17308
17309
17312
17317
17330
17335
17355
17363